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THE OKAPI AND ITS NATIVE WILDS.

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SIR HARRY JOHNSTON'S DISCOVERY.

The curiosity of both the scientific world and the general public was stirred, a few years ago, by the announcement that a new animal of large size had been found in Central Africa. The world is now so circumscribed that in some lines of search there is little left to be discovered, and few people imagined that a large and strange mammal would be among the unknown.

The discoverer was Sir Harry Johnston, and as is so often the case, he found hints which directed his attention to the search. Stanley in his "In Darkest Africa" states that the Congo dwarfs know of an animal of ass-like appearance which exists in their dense forest, and which they catch in pitfalls. The occurrence of anything like a horse or an ass—animals partial to treeless, grassy plains—in the depth of a large forest seemed so strange that Johnston determined to take the first chance to investigate.

Later he learned from the dwarfs of a creature which the natives called Okapi, a creature like a zebra, but having the upper part of its body a dark brown; and with feet divided into more than one hoof. He believed that he was on the track of a three-toed horse and organized a hunt, but without success. A few fragments of skin were obtained from the natives, and sent to London, where the animal was classified as a new zebra.

At length Johnston secured a complete skin and found the animal to be more wonderful than he had imagined. Instead of being a zebra the okapi appeared to be a near ally of Helladotherium, a fossil species found in Greece and Asia Minor. Its nearest living relation is the giraffe. Johnston describes it as in size that of a large stag. It stands relatively higher in the legs than any of the ox tribe. Like the giraffe, it has only two hoofs, and no remains whatever of the other digits which are represented in deer, oxen, and most antelopes by the two little "false hoofs" on either side of the third and fourth toe. The coloration of the okapi is quite extraordinary. The cheeks and jaws are yellowish white, contrasting abruptly with the dark-colored neck. The forehead is a deep red chestnut; the large, broad ears are of the same tint, fringed, however, with black. The forehead ranges between vinous red and black in tint, and a black line follows the bridge of the nose down to the nostrils. The muzzle is sepia-colored, but there is a faint rim or mustache of reddish-yellow hair round the upper lip. The neck, shoulders, barrel, and back range in tone from sepia and jet black to rich vinous red; the belly is blackish. The tail is bright chestnut red, with a small black tuft. The hindquarters and hind and fore legs are either snowy white or pale cream color touched here and there with orange. They are boldly marked with purple-black stripes and splodges which give that zebra-like appearance to the limbs of the okapi that caused it to be first considered as a new striped horse. The hair is very short and its appearance singularly sleek and glossy.

Almost all trace of horn has disappeared; nothing is left but minute twists of hair found in the skin just above rounded knobs of horn-cores, which have disappeared. Its relation the giraffe still retains three horny prominences on the skull which were once the bases from which horns or antlers sprung. It is not definitely known whether the animal has a prehensile tongue like the giraffe; but it has long and flexible lips. It is said by the natives to live entirely on leaves and small twigs which it probably gathers by its lips and tongue, for its front teeth are weak.

So far as is known the okapi is confined to the northern part of the Congo forest, the mightiest forest in the world. Here, probably, man is its only foe, for lions never penetrate into the dense growth, and the forest leopards are arboreal, catching monkeys for their food.

The future of the okapi is an interesting question. Will it be exterminated in a few years or will the British and Belgian governments, in whose territory it ranges, be able to protect it? At present it seems secure, for it is a shy animal, living in pairs, in the depths of the vastest woods known to man. But timber is growing scarce, and the next generation may see lumber mills in the heart of Africa. A railway is already under construction to Uganda—the British haunt of the okapi—and there are signs that that country will soon be a haunt of the tourist and the sportsman.

There are probably other secrets in the great forest. A giant ape, larger than the gorilla, is believed to be there, and doubtless there are smaller new animals. From Uganda comes the five-horned giraffe, the tallest mammal in the world; the finest elephants with the largest tusks; the weirdest birds, and the largest fish to be found in Africa. Sportsmen are already drifting there, and if they are unchecked many creatures will be exterminated. But there is hope that effective legislation will step in to protect the okapi and some of the other denizens of Central Africa. We are indebted for our illustration to the Illustrated London News; the animals are copied from a specimen stuffed by Mr. Rowland Ward, and the setting is copied from a photograph, taken by Major Powell-Cotton, of a drinking place of the okapi.

PROGRESS OF ZOOLOGY.

AMERICAN PIONEERS IN DEEP SEA EXPLORATION.*

BY ALEXANDER AGASSIZ.

I have the honor on behalf of the American zoologists to welcome here the zoologists who have honored us by their presence. I wish this pleasant duty had fallen to the lot of one younger than myself, who had not yet passed the allotted three-score years and ten; one who could look forward with the younger and more active members of our congress, and be a zealous co-operator in the plans and schemes of the new zoology of the coming century, and not be, as I must, a passive looker-on, though an interested one.

A mere glance at the programme of this meeting cannot fail to emphasize the many and varied interests which claim the attention of the members of this congress.

Zoology, as it was understood in the days when my contemporaries were commencing their careers, covered a comparatively limited field, the whole of which could be grasped by any one of its devotees, who were not compelled, as are the students of to-day, to confine their researches to specialties if they wish to share in the advance of the field of science they have selected. No one person can hope to tread the range of the whole of zoology as subdivided in our days. To be a master in a small, circumscribed field from which to judge and test the application of general theories, is about all any one of us may hope to do.

Nothing is, perhaps, more marked in modern zoology than the great inroads which physiology has made into the methods of zoology. Our zoological laboratories have to a great extent become laboratories of animal physiology. All the questions of morphology, of systematic zoology, of geographical distribution, have been relegated to a position of comparative insignificance, while speculation and mathematics have assumed in the new zoology an importance which tends to overwhelm research in the phenomena underlying all study of nature. We can no longer claim to be making a "scientific use of the imagination." We seem to have entered what we might call the period of the scientific abuse of imagination.

Following the precedent set for us by former zoological congresses, we shall hope to hear from some of our foreign visitors on subjects of general interest, and leave to the sections and their meetings the discussions of the specialists who have a common interest in more limited fields.

Taking the example of some of my predecessors in office, you will allow me to sketch briefly the part I have taken in some of the modern problems of zoology.

As one who for nearly forty years has followed, to the exclusion of all other and former studies, the new fields of inquiry opened by the deep sea explorations of the last part of the previous century, in which Americans, English, Scandinavians, French, Germans, Austrians, Italians, Russians, and Dutch have taken a prominent part, I may be excused if I attempt to interest the members of the congress in a short sketch of the share Americans have had as pioneers in that field.

We must go back to 1846, when, under the auspices of Bache, the first investigation of the Gulf Stream was undertaken by the Coast Survey, and to the early days of 1867, when Pourtales, in the U. S. C. S. S. "Corwin," dredged to the then great depth of six hundred fathoms. Almost simultaneously with this, in 1868, occurred the trial trips of the "Lightning" and "Porcupine" under the lead of Carpenter, Thomson, and Jeffreys. These expeditions on the part of the English led to the "Challenger" expedition—the three-year-cruise of which, under Thomson, laid the foundation of oceanography. On the American side the "Challenger" was followed by the expeditions of the U. S. C. S. S. "Blake," of which I had the good fortune to be in charge. For three seasons the "Blake" carried on work similar to that of the "Challenger" along the east coast of the United States from the banks of Newfoundland to the Gulf of Mexico, and through the Caribbean Sea.

On her first cruise the "Blake" was in command of Lieut.-Commander Sigsbee, to whose inventive skill were due many of the devices facilitating the work on the "Blake." The apparatus in use by the "Blake" has with slight modifications been adopted by the subsequent deep-sea expeditions which have extended and supplemented the work laid out in its grand outlines by the "Challenger" and "Blake."

The work of the "Princess Alice" under the Prince of Monaco included part of the Mediterranean and the Eastern and Northern Atlantic from the Azores to Spitzbergen. The French vessels, "Travailleur" and "Talisman," with Alphons Milne-Edwards and Perrier, explored the Atlantic somewhat south of this area.

The Red Sea was examined by the "Pola" under Steindachner, the Indian Ocean by the "Investigator," in charge of Alcock. A German expedition in the "National," under Hensen, was sent out to study the pelagic fauna of the Northern Atlantic, and another German deep-sea expedition, that of the "Valdivia," in charge of Chun, examined parts of the Atlantic not covered by former expeditions, and a great part of the Indian Ocean not included by the "Investigator." I need not mention a number of minor expeditions undertaken for specific purposes.

Our knowledge of the hydrography of the Antarctic region, where at the beginning of the past century a couple of deep-sea soundings were made by Ross, has been vastly enlarged by the expeditions of the "Discovery," of the "Gauss," and of the "Belgica," while each Arctic expedition, where the first sporadic deep-sea hauls were made in 1861, by Swedish expeditions under Torrell, and more especially those of the "Vöringen" and "Fram," have enlarged that of the Arctic seas.

With the exception of the expeditions of the "Princess Alice" and of those of the "Albatross," the leaders of the cruises I have named were limited to single expeditions, while it has been the good fortune of the Prince of Monaco, as well as of myself, to have been able year after year to go on with our work and carry on continuous oceanic researches.

The results of these numerous expeditions have been partially published. Those of the "Challenger" have been completed, thanks to the energy and devotion of Sir John Murray, and the noble file of volumes of the voyage of the "Challenger" will ever remain a monument of oceanic research.

The publications of the "Gazelle," "Blake," "Travailleur," the "Talisman," the Norwegian North Atlantic Expedition, the "Ingolf," the "Investigator," "Pola," the "Planeton" expedition, the "Irboga," the "Princess Alice," the "Valionia," another "Albatross," while not so extensive, yet fill many of the gaps left by the "Challenger" explorers, and a glance at these interesting volumes treating of the physics, chemistry, zoology, and geology of the oceans are evidence of the great influence these researches have had upon the development of thalassography.

I may close by especial reference to the work of the U. S. F. C. S. "Albatross," built in 1883 under the supervision of Prof. Baird, as a steamer for fishery work. She soon took her place, owing to her superb equipment, as the boat best adapted for marine investigation. For several years she was occupied in exploring the east coast of the United States from the Banks of Newfoundland to the extremes of the Caribbean Sea. Her field of operation was next transferred to the Pacific, and her track became a thread of most interesting observations connecting the fauna of the Southern Atlantic to that of the Pacific, through the Straits of Magellan as far as California. Then began a systematic exploration of the west coast of the United States, of the fisheries of Alaska, and of the Aleutian Islands. Next, hydrographic work along the coast of Southern California, of Mexico, across to the Sandwich Islands, and repeated trips to Japan in the interest of fisheries and hydrography.

I was fortunate enough thrice to be placed in charge of the "Albatross," once for an extended exploration of the Panamic region, when she was commanded by Tanner, that veteran deep-sea dredger. A second time,

* The inaugural address of Dr. Agassiz as President of the International Congress of Zoologists, delivered in Boston, Monday, August 19, 1907.

when she swept for more than nine months through the Pacific, from San Francisco to the Marquesas, the Paumotus, Society Islands, Tonga, Fiji, Ellice, Gilbert Islands, to the Marshall, Carolinas, and Guam, winding up in Japan. On this expedition I had the opportunity of making extensive observations on coral reefs, which supplemented those I had in previous years made in Florida, the West Indies, Galapagos, on the Great Barrier Reef of Australia, and in the wonderful coral regions of Fiji and of the Moldives. These observations have greatly modified our views regarding the formation of coral reefs. But this is not the place to discuss the older theories.

Finally, I was in charge of the "Albatross" a third time, when she steamed through the eastern Pacific, covering one of the most interesting of oceanic areas, practically a *mare incognitum*, an immense rectangle bounded by lines drawn from the coast of South America, thence to Easter Island, to the Galapagos, to Mangareva and Acapulco, a region of the Pacific which had not been visited by former expeditions.

The results of these expeditions of the "Albatross" have been issued as far as completed in the publications of the Museum of Comparative Zoology, and to my many colleagues in this country and in France, Germany, Austria, Russia, England, Italy, Denmark, Holland, Norway, Sweden, and Japan, who have so kindly devoted their time and skill to the preparation of the reports on the collections and data obtained, I am deeply grateful. Of these collaborators there have been ninety-four, and forty-four are still at work on parts of the collections. It will undoubtedly seem strange to my European hearers to be informed that the publications of the "Albatross" expeditions have not been cared for by the federal government. It certainly seems an anomaly that the enormous amount of material collected so diligently by the "Albatross" for more than twenty years at a very great outlay should be accumulating in the storerooms of the National Museum and in the archives of the Fish Commission for want of a very moderate appropriation, compared to the cost of collecting the data, to publish the results which have been brought together. This neglect is the more strange as with the exception of the "Princess Alice," the "Albatross" is the only government vessel which has been built for deep-sea work and kept in constant commission for a period of twenty-five years.

The problem which presented itself as of the greatest interest in connection with my deep-sea work was the study of the marine fauna on the two sides of the Isthmus of Panama. Much has been written on the relationship of the marine animals of the Caribbean and of the Panamic region, but the speculations are all based upon data supplied by collections made upon the littoral regions.

It was not until the collections made by the "Blake" on the Atlantic and Caribbean side, and those made by the "Albatross" on the Panamic side, were studied, collections extending to the deepest waters of both regions, that we were able to speculate with some degree of certainty upon the causes which led to the existence of the peculiar fauna characteristic of the deep waters of the Caribbean, a fauna more closely allied to the Panamic deep water fauna than to that of the Atlantic, and suggesting that after the formation of the Windward Islands, which in great part cut off the Caribbean from the Atlantic, there must have been a free connection with the Panamic region of a depth greater than that which connected it with the Atlantic.

It of course became necessary to carry on geological surveys to determine the age at which these connections were established, and again closed, to obtain some measure of the time elapsed necessary to differentiate the marine fauna of the two sides of the Isthmus of Panama. While the length of this period can only be vaguely inferred, it gives us at any rate the comparative measure of the changes which have taken place in these faunæ from the time when the marine fauna of the later crustaceous period was passing into the older and more recent tertiaries, and until the existing state of things was established. The preliminary geological studies I carried on in connection with the study of the West Indian coral reefs, necessary to determine the age of the development of the larger Antilles and of the Windward Islands, have been extended for me by Hill and others, so that we now have a fair idea of the geological sequence of events in the growth of the Caribbean area.

The careful, comparative study of the collections of the "Blake" and "Albatross" is now nearly complete—a study carried out by specialists is absolutely essential, for no mere superficial sketch even by an experienced zoologist will suffice in drawing conclusions of any value and bring out the minute, interesting, fundamental details which no general zoologist can hope to grasp. Whatever final value the correlation of these reports may have will be due to the assistance I have received from my collaborators in so many special fields, and my indebtedness to them I find it difficult to express.

LABOR'S SHARE.

THREE TIMES CAPITAL'S REWARD IN PRODUCTIVE INDUSTRY.

To a certain extent the question raised by the Socialist is a fair one and deserves fair investigation and an honest answer. Is the rapid increase of wealth a threat against the welfare of the people as a whole? If we concede, for the sake of argument, that payments for the use of capital are a burden—a fixed charge—upon production, it is reasonable to inquire how great has this burden become?

The United States Census Bureau has recently issued a volume containing information which, it seems to us, may be fairly made use of to test the claims of socialism. The volume is entitled "Wealth, Debt, and Taxation." It gives what is doubtless the most accurate and careful estimate ever made of the total wealth of the United States. The estimate is made for the year 1900 and the year 1904. In the former year the total value of all property in the United States is set at \$88,500,000,000. In the latter year the total was \$107,000,000,000.

These figures by themselves mean nothing. They are too huge for comprehension. But if it were possible to draw from them an approximate estimate of the total income which capital, or accumulated wealth, receives, and if we could then compare this income with the total earnings of labor, the comparison might contain some useful lessons.

Let us take first the task of estimating the total income which capital receives. The census report before us classes the total wealth of the United States as follows:

Real property and improvements	\$62,341,000,000
Live stock	4,074,000,000
Farm implements and machinery	845,000,000
Manufacturing machinery, tools and implements	3,300,000,000
Gold and silver coin and bullion	2,000,000,000
Railroads and their equipment	11,245,000,000
Street railways, shipping, waterworks, electric light and power systems, telegraph and telephone systems and canals	4,841,000,000
All other property—products of agriculture, manufactures and mines, merchandise, clothing, furniture, carriages, and miscellaneous personal property	18,462,000,000

In our task of ascertaining the income on the invested wealth of the United States we must recognize first that not all the wealth in the above table yields any income. Of course all the personal belongings included in the last item—furniture, clothing, provisions, etc.—are not invested and yield no income to their owners. These things are the product of combined labor and capital, all the time being poured forth and as rapidly being used up.

It is doubtful whether real estate, which is seen above to constitute the bulk of the property of the United States, would show anything like as large an average return as the railways; but as we are aiming to find the maximum possible drain that capital may be making on the country we will assume that railway capital represents a fair average of the rate of income produced by all wealth. On this basis \$80,812,000,000 of invested capital at 4½ per cent would yield an annual return of \$3,636,540,000.

And now let us turn and study the side of labor. The population of the United States on June 1, 1904, is placed by the census at 81,256,000. It was 76,000,000 in round numbers in 1900. The number of wage earners, or "persons engaged in gainful occupations," was given by the census of 1900 as 29,286,000. At the present time, therefore, this number must be swelled to some 31,000,000. We believe, however, that this is in excess of the true number of wage workers, as it includes those who are past the age of active work and those who are incapacitated for other reasons. A more accurate method, we believe, is to estimate one worker to each three and one-half persons, which would give a total of 23,200,000 wage earners in round numbers.

What are the average annual earnings of these workers? For a guide in answering this question we turn again to the Interstate Commerce Commission railway statistics, and find there that in 1905 there were 1,382,000 men employed on the railways of the United States who received wages and salaries amounting to \$840,000,000, or an average of \$608 per employee. Again, the census report on manufactures, just issued, shows that in 1905 there were in round numbers 6,000,000 persons engaged in manufacturing industries who received wages and salaries amounting to \$3,186,000,000, or an average of \$531 each. Similar statistics are not available for other occupations, but it will probably be generally agreed that the 1,500,000 persons engaged in professional occupations receive a higher average than this, while the 10,500,000 persons engaged in agriculture and the 5,500,000 in domestic and personal service receive considerably less. All things considered, \$450 per annum seems as low a figure as can reasonably be estimated as the earnings of the average worker.

Multiplying now the total number of wage earners found by these average earnings, we have the total compensation paid to labor in a year at \$10,440,000,000.

If these figures be accepted, then it appears that capital is now receiving about one dollar where labor is receiving three; or, to put it another way, if the annual product of the country is divided into four equal heaps, capital is getting one of these heaps and labor the other three.

But in making this comparison between the earnings of capital and the earnings of labor, we must be careful not to make the common mistake of identifying capital with wealth and labor with poverty. A large part of the \$107,000,000,000 of wealth in the United States is actually the property of the wage workers themselves. The huge accumulations of wealth by the few multi-millionaires bulk large in the popular mind; but they are really small compared with the accumulated savings of the millions of people of moderate means. The deposits in the savings banks of the United States last year exceeded \$3,482,000,000. That this is the property of people of small means is well known to every one, and is practically proved by the fact that the average size of each deposit is only \$433.79. The assets of life insurance companies, totaling over \$2,700,000,000, are likewise chiefly made up of the savings of those of small means. The farms of the United States are valued at \$16,615,000,000, and 5,690,000 families live upon them, giving an average holding per family of only \$2,920.

Wealth that is so widely distributed certainly contains no threat against the public welfare and gives no foundation for the arguments of the Socialist. He must confine his agitation against property to the holdings of the wealthy if he would command a hearing. The preceding discussion shows that the total holdings of those that may be classed as wealthy must be only a part, and probably a small part, of the existing \$80,812,000,000 of income-producing wealth.—Engineering News.

DEEP WELLS THAT FEEL THE SEA.

In their investigation of the underground water resources of the Coastal Plain of Virginia, the geologists of the United States Geological Survey have collected data relating to the many hundreds of artesian wells that yield excellent water in large areas of the coastal region. Particular note has been made of the quantity and quality of the supply afforded by wells that give flows at the surface. The water of most of these wells is admirably adapted to household uses, though that of some of them contains enough mineral salts in solution to make trouble in boilers used for steam production.

The variation in flow exhibited by these wells with the rise and fall of the tide is of peculiar interest, the flow being notably greater at the flood than at the ebb tide. It is the general opinion among well drillers that practically all flowing wells near tidal rivers or inlets from open bays do feel the distant sea, but some of them so slightly that the variation in flow is not noticeable.

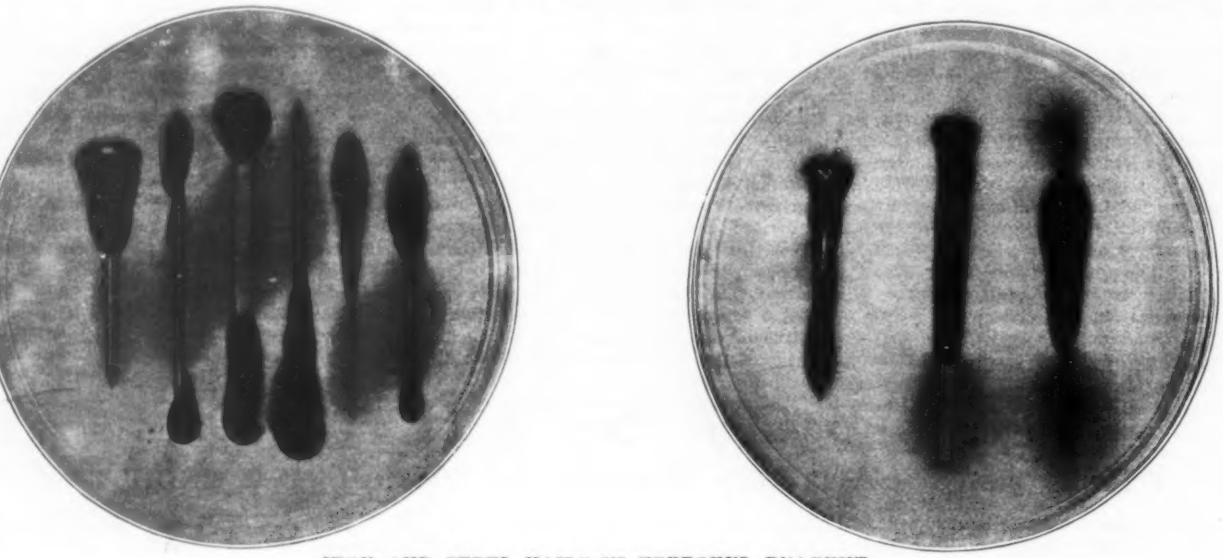
The geologist in charge of the ground-water investigations in Virginia states that changes in water level in wells, due to fluctuations in the height of the surface of some neighboring body of water, have been observed all over the world. It is customary to explain these changes by supposing a direct connection between the river, lake, or bay; but in many places, as in Eastern Virginia, such connection is clearly impossible, owing to the depth of the wells and the nature of the intervening beds, some of them dense, tough marls and clays. These beds, however, though they do not transmit water, nevertheless contain it, and as water is practically incompressible, any variation of level on the river or bay is transmitted to the well through the water-filled gravels, sands, clays, and marls. When a porous bed is tapped by a well the water rises to the point of equilibrium and fluctuates as the hand of the ocean varies its pressure on the beds that confine the artesian flow.

THE ELECTROLYTIC THEORY OF THE CORROSION OF IRON.—II.*

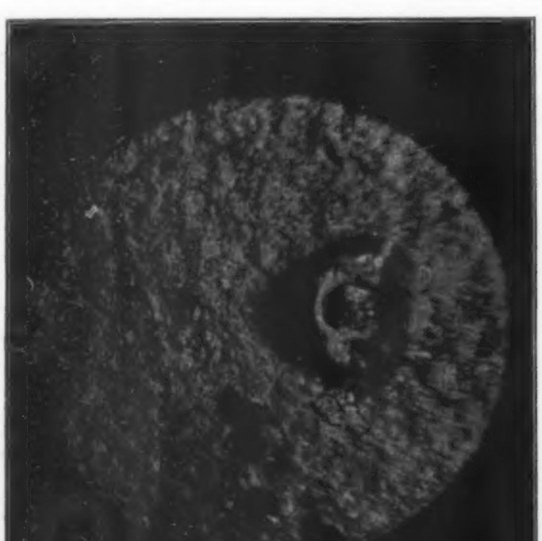
THE REAL CAUSE OF IRON RUST.

BY DR. ALLERTON S. CUSHMAN.

Concluded from Supplement No. 1652, page 139.



IRON AND STEEL NAILS IN FERROXYL REAGENT.



FORMATION OF CRATER WITH PITTING EFFECT IN CENTER. (ENLARGED 45 DIAMETERS.)

FORMATION OF CONE WITH PITTING EFFECT IN SURROUNDING AREA. (ENLARGED 45 DIAMETERS.)

WHENEVER a specimen of iron or steel is immersed in water or a dilute neutral solution of an electrolyte to which a few drops of phenolphthalein indicator had been added, a pink color is developed. If the solution is allowed to stand perfectly quiet it will be noticed that the pink color is confined to certain spots or nodes on the surface. The pink color of the indicator is a proof of the presence of hydroxyl ions and thus indicates the negative poles. Many persons who are interested in the metallurgical problems connected with the iron and steel industry may not be familiar with the modern theory of indicators, and therefore an explanation of the manner in which phenolphthalein shows the presence of hydroxyl ions by the formation of a pink color will not be out of place. Phthalic acid was first prepared by Laurent in 1836 by the oxidation of naphthalene, and was first called naphthalinic acid. It was afterward shown that the compound was not directly related to the naphthalene structure and Laurent changed the name to phthalic acid, the derivatives of which became known later as phthaleins. Phenolphthalein is a product which is formed by the condensation of two molecules of phenol or carbolic acid with the anhydride of phthalic acid. It is in its nature so weak an acid that it is not dissociated in solution, and as the molecule is colorless, no color is seen when it is added to a perfectly neutral solution. If, however, an alkali is added the corresponding salt of the weak acid is formed, which immediately dissociates with the formation of a colorless metallic cation and the strongly rose-colored organic anion. Thus all hydroxides of basic elements will show the pink color in solution, even when present in only the slightest excess. On this account phenolphthalein is an exceedingly delicate indicator of the presence of hydroxyl ions.

Since phenolphthalein shows only the nodes where solution of iron and subsequent oxidation can not take place, Prof. W. H. Walker suggested the addition of a trace of potassium ferricyanide to the reacting solution, in order to furnish an indicator for the ferrous ions whose appearance marks the positive poles. If iron goes into solution, ferrous ions must appear, which, with ferricyanide, form the well-known Turnbull's blue compound. Going a step further, Walker suggested stiffening the reagent with gelatin and agar-agar, so as to prevent diffusion and preserve the effects produced. For this combined reagent, which indicates at one and the same time the appearance of hydroxyl and ferrous ions at opposite poles, the writer has suggested for the sake of brevity the name "ferroxyl." The reagent is prepared and used in the following manner: A hot solution of the purest agar-agar or gelatin in distilled water is carefully neutralized with one-hundredth normal potassium hydroxide, using phenolphthalein as the indicator. When exact neutrality has been obtained a few drops of a dilute solution of potassium ferricyanide is added. When a layer of the reagent is poured into a dry Petri dish floating in ice water it should stiffen into a firm jelly in a few minutes. The polished specimens are laid carefully on the jelly and flooded with another layer of the reagent. After the preparation has hardened it should be covered and set away in a cool, dark place. In the course of a few hours the negative and positive zones will begin to develop in red and blue. If the reagent has been properly prepared the color effects are strong and beautiful. In the course of a few days the maximum degree of beauty in the colors is obtained, after which gradual deterioration sets in. The best results obtained by the writer are illustrated.

The areas which show with sharp outlines in the reproduction are the blue positive nodes, while the pink negative nodes appear with hazy outlines. In the pink zones, as would naturally be expected, the iron remains quite bright as long as the pink color persists. In the blue zones the iron passes into solution and continually oxidizes, with a resulting formation of rust. Even the purest iron develops the nodes in the ferroxyl indicator, but impure and badly segregated metal develops the colors with greater rapidity and with bolder outlines. This result would of course be expected, as in pure iron the formation

* Abstracted from a Bulletin on "The Corrosion of Iron," issued by the Office of Public Roads, United States Department of Agriculture.

of poles would be conditioned by a much more delicate equilibrium than in impure iron, where changes in concentration of the dissolved impurities would stimulate the electrolytic effects. Even so-called chemically pure iron contains small quantities of dissolved gases, and it is not improbable that even slight variations in the physical homogeneity of pure iron will occasion the electrolytic effects which are made visible by this delicate reagent.

It has been noted by a number of investigators that different samples of iron and steel do not rust in the same way when subjected to the action of water and air. While some samples show localized electrolytic action, as indicated by deep pitting, others become covered with a more or less homogeneous coating of hydroxide, which shows little or no tendency to localize in spots or nodes. The question naturally rises: In what respect do these two methods of rust formation differ? A close inspection of the large illustration suggests a probable answer in this respect. The photographic reproduction exhibits an effect which is frequently observed in the ferroxyl tests. When the colors first developed, two dark blue nodes formed at the opposite ends of the test piece, with a large pink area in the center, where for a time the metal remained quite bright. Very shortly, however, the poles changed, and the pink central area disappeared and gave way to a large blue node which enveloped three-quarters of the test piece, with a small opposed pinkish spot. Again and again a reversal and change of poles took place, and at least five such changes are clearly shown in the photograph. As a result of this action the metal strip was rapidly covered over its entire surface with the same superficial, loosely adherent coating of hydroxide, which is obtained in many cases when certain samples of iron and steel are allowed to rust under a layer of water. It is presumable that as the surface of the metal is eaten into by the solution of the iron at the positive poles, a new condition of equilibrium occurs, resulting in changes and even reversals of the positive and negative nodes. This would indicate that in the case of metals which suffer from local action or pitting the segregation conditions are of a different nature from those which exist in the case of metals which rust more evenly. A rough analogy may be drawn by imagining an imperfect mixture of black and white sand, the respective grains of which may lie in streaks, spots, and layers, or may tend to arrange themselves in some more or less uniform relation to each other. The best demonstration that the rusting and corrosion of iron and steel in all its forms is essentially an electrolytic phenomenon is afforded by the fact

STEEL NAILS IN FERROXYL REAGENT.

that it has not as yet been possible to find a specimen of such purity that no trace of positive and negative nodes will be formed in the ferroxyl indicator.

We may now apply the electrolytic theory to the actual results obtained in the ordinary rusting of iron. If a section of rolled metal such as sheet or plate is immersed in water, if the electrolytic theory is correct, rusting must take place with the establishment of positive and negative spots or areas. At the positive points iron will pass into solution and be rapidly oxidized to the loose colloidal form of ferric hydroxide which is characteristic of rust formed under these conditions. It is a well-known fact that colloidal ferric hydroxide will move or migrate to the negative pole if subjected to electrolysis. We may therefore consider the possibility of two separate effects that may be produced, viz., when a positive center is surrounded by a negative area, and *vice versa*. These two conditions may be graphically represented by the two circles *A* and *B* shown in the diagram.

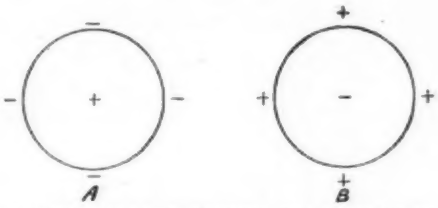
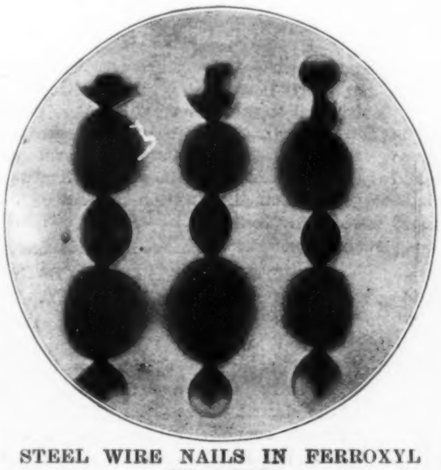
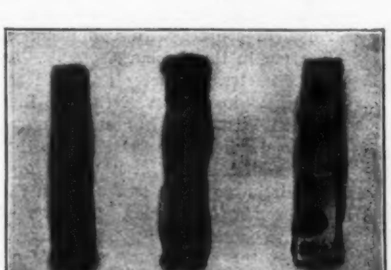


DIAGRAM ILLUSTRATING ELECTROLYTIC ACTION ON THE SURFACES OF IRON AND STEEL.

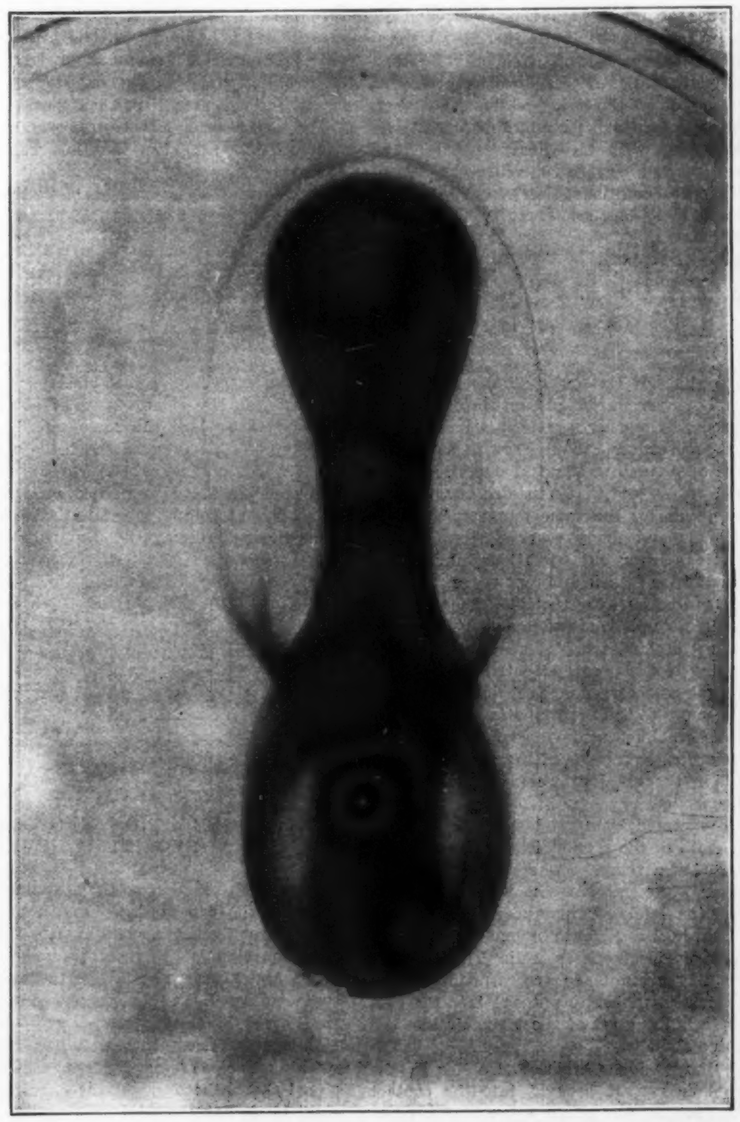
Now, as rusting proceeds we should expect in the case of *A* that the ferric hydroxide would be piled up in a crater formation, while the metal is eaten out at the center. In the case of *B* the effect would be reversed, and while the metal would be attacked in the surrounding area the hydroxide would be piled up in a cone at the center. That this is precisely what is taking place whenever a sheet of metal rusts under water a low-power microscope very clearly shows. In two illustrations the writer has succeeded in showing the existence of both the craters and cones as they formed on the surface of a piece of wrought-iron boiler plate. In one a typical crater surrounding the point of pitting is shown, while in the other an excellent example of the cone appears. Both are photomicrographs magnified about 45 diameters. The source of light was on the right in each case and the shadows indicate the crater and cone formation, which is so clearly discernible under the microscope. The writer obtained other photographs of the rusted metal, showing the craters and cones as they appeared with very low magnification.



STEEL WIRE NAILS IN FERROXYL REAGENT.



WROUGHT IRON, CHARCOAL IRON, AND STEEL IN FERROXYL.



STRIP OF STEEL IN FERROXYL REAGENT, SHOWING FREQUENT REVERSAL OF POLES.

Experiments were made with strips of Bessemer steel, puddled wrought iron, and with charcoal iron prepared in the following manner: The respective samples were turned off in a lathe to a bright, smooth finish; they were then immersed under a thin layer of the ferroxyl reagent and allowed to stand quietly for several days. At the end of this time the surfaces were wiped clean. The electrolytic effects, which had been active on all three metals, were very well illustrated. Light portions showed the negative areas, where little or no rusting took place, while dark spots and areas showed the special points of attack, with the pitting effects. The etching was not, of course, deep in the case of any of the three samples and should not be understood as showing the relative rate of corrosion of the different types of metal. The experiment simply served as a demonstration that the rusting in each case had been accompanied by electrolysis.

A close examination was made of the actual pitting of a boiler tube, which failed, after eighteen months' service, in a water-tube type of marine boiler. The conclusion that pitting was due to electrolysis seemed

justified by comparing this effect with those obtained by experiments.

The evidence advanced in the preceding pages appears to the writer to confirm the conclusion that the whole subject of the corrosion of iron is an electrochemical one, which can be readily explained under the modern theory of solutions. It is an undeniable fact that some irons and steels suffer corrosion very much more rapidly than others, and the underlying causes for these differences constitute one of the important problems of modern metallurgy.

Although the discussions brought forward in this bulletin are mainly theoretical in their nature, it is quite apparent that they also have an indirect practical bearing. Before advance can be made in overcoming the difficulties in the way of manufacturing iron which shall have the maximum resistance to corrosion, as well as the preservation of the metal under the conditions of service, the underlying causes must be thoroughly understood. If we accept the electro-chemical explanation of the corrosion of iron, there can be no doubt that conditions which inhibit electrolytic effects also inhibit corrosion, and *vice versa*. The purer the iron in respect to certain other metals which differ electro-chemically from iron and the more carefully lack of homogeneity and bad segregation are guarded against the less likely are the electrolytic effects to become serious. These points constitute the essential problems which confront the manufacturer who desires to make a product which shall have a high resistance to corrosion. The user and consumer, however, are interested in the protection of the various types of merchantable iron and steel which are available under market conditions at the present time. In short, protective coatings and palliative methods of treatment are in greater demand to-day than ever before. From the standpoint of the electrolytic theory many suggestions for experiment under the conditions of service present themselves. The fact that hydroxyl ions inhibit the rusting of iron has been made practical use of for a long time past, and it is not unusual to add caustic alkalis to boiler waters for this reason. This, however, frequently causes trouble from foaming and, as Cribb has shown, if an insufficient amount of alkali is present the pitting effect is accentuated rather than inhibited. This observation is in accord with the theory that the hydroxyl ions must reach a certain concentration, which varies with different conditions, before entire prohibition of the electrolytic effects is obtained.

At concentrations much below those necessary to prohibit electrolysis the action is similar to that obtained by adding a neutral electrolyte to the water, i. e., the electrolytic effects are localized if not stimulated. There should be many cases, however, where the property of alkalis to inhibit corrosion could be made of more practical use than has been done. Whenever iron posts or standards are set directly in the ground instead of being imbedded in concrete, the liberal use of slaked lime should be beneficial.

The expedient of using metallic zinc in boilers to overcome the local electrolytic effects in the iron by producing a still greater electrolytic effect at the almost exclusive expense of the more positive zinc is well known and has been in use for a long time. Although the theory on which the use of zinc for this purpose is based is sound, great difficulty has been encountered in maintaining good metallic contacts between sufficiently large surfaces of the two metals under the conditions which maintain in a boiler. From what has been shown in regard to the inhibitive action of the chromates it is not improbable, since such dilute solutions prevent electrolysis and corrosion, that the addition of small quantities of bichromate to boiler waters would be highly efficacious in preventing the rapid pitting which has caused so much trouble. It has lately been reported that steel boiler tubes used on vessels fitted with turbine engines suffered corrosion to the point of failure in from two to four months' service. This was found to be due to the fact that the steam, containing perhaps volatile acids, impinging on the bronze turbine blades, carried copper into solution and through the condensers into the boiler. Since iron does not change places with copper in dilute solution containing bichromate, it is possible that here again this salt would be found of practical value. That this statement is correct can easily be shown. If a bright piece of iron is immersed in a solution of copper sulphate so dilute as to show only a faint bluish tinge, the iron will nevertheless turn dark from precipitated copper in a very few moments. If, now, potassium bichromate is added in only just sufficient amount to give a yellowish instead of a bluish tinge to the solution, iron will remain bright and copper will not be deposited.

The experiment has been made by the writer of keeping iron and steel in dilute boiling solutions of bichromate for protracted periods at the same time that a current of air was bubbling through the boiler, and as long as the strength of the solution was equal to or above one one-hundred-and-sixtieth normal no rusting has ever taken place. Since this strength is approximately equivalent to one pound of the salt in 1,500 gallons of water, there seems to be no reason why potassium bichromate should not come into use as a boiler protective. The application of the various inhibitors in the priming coats of paints and other protective coverings has already been to some extent made use of, and it would appear that slightly soluble chromates should be theoretically the best protectives for the first application to iron and steel surfaces.

A very widespread impression prevails that charcoal iron and puddled wrought iron are more resistant to corrosion than steel manufactured by the Bessemer and open-hearth processes. It is by no means certain that this is invariably the case, but it would follow from the electrolytic theory that in order to have the highest resistance to corrosion a metal should either be as free as possible from certain impurities, such as manganese, or should be so homogeneous as not to retain localized positive and negative nodes for a long time without change. Under the first condition the irons would seem to have the advantage, but under the second much would depend upon care exercised in manufacture, whatever process was used.

The evidence appears to be conclusive that the corrosion of iron in all its forms is primarily due to hydrogen ions. The ability of various samples to resist the attack of an acid of a standard strength may turn out to bear some relation to resistance to corrosion under service conditions. A great variation in resistance to acid corrosion is shown by different specimens of both iron and steel. An investigation of this subject is being made in connection with the work of Committee U of the American Society for Testing Materials. Carelessly made and poorly segregated metal will be easily attacked, no matter what it may be called or what method was used in its manufacture. As has already been pointed out, there are two lines of advance by which we may hope to meet the difficulties attendant upon rapid corrosion. One is by the manufacture of better metal, and the other is by the use of inhibitors and protective coverings. Although it is true that laboratory tests are frequently unsuccessful in imitating the conditions in service, it nevertheless appears that chromic acid and its salts should under certain circumstances come into use to inhibit extremely rapid corrosion by electrolysis and so tend to the preservation of iron.

DISTANT OPERATION BY HERTZIAN WAVES.

GARET'S APPARATUS.

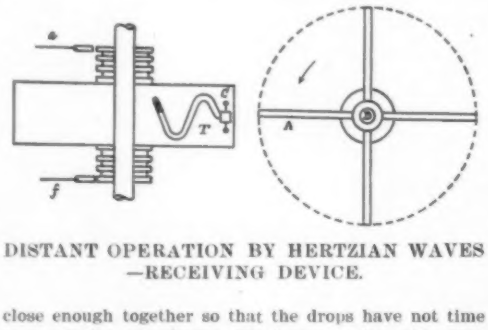
A French scientist, G. Garet, has invented an improved device for working a distant apparatus, as, for instance, a torpedo, by means of electric waves. It is asserted that the apparatus can be used to solve the difficult problem of distant mechanical operations carried on by aerial waves, and that it is also adapted for use on a wire circuit for the same purpose; likewise for railroad signals and many other devices. With a single wire it can carry out operations which now take as many as ten or fifteen different wires.

Referring to the diagram, the receiving apparatus is made up of a single wheel *A*, movable about a shaft *B*, and carrying a set of blades or disks in any number, each corresponding to a separate circuit in the device which is used, such as a torpedo. Each blade makes a contact when it comes to the proper point or brush for carrying the current. Such contacts carry out the propulsion, steering, etc., by means of motors or electromagnets placed in the different work circuits on the torpedo or other device.

The wheel is operated by a ratchet which turns it around. Each tooth of the ratchet is made to advance by a pawl worked by a relay. The relay is in the circuit of a coherer which receives the waves from the sending station (on land, for instance). Each wave signal causes the wheel to advance by one tooth, and in the present case by one blade as well. The operator can thus bring any given blade (corresponding to a work circuit which he wishes to put on) into the contact position by sending a set of short signals like the dots of the Morse alphabet.

What is peculiar to Mr. Garet's device lies in the fact that the blade can be brought into the contact position without having any of the other blades make a contact of any kind by their passage over the same point. Each blade carries a bent glass tube *T* with the air exhausted and containing a drop of mercury. In all the upper blades the mercury lies at the lower or inner end, but in the lower blades the mercury is at the outer end of the tube. There is one special position for each blade where the mercury leaves the center and moves to the periphery, and this is the position of contact, where the blade clears the horizontal position.

Each outer end of the tube carries an ebonite cap *C*, with two metallic points placed so that the mercury completes an electric circuit when at this point. When a blade comes into the contact position or angle the mercury does not at once reach the ebonite cap, but is delayed in a manner which can be well adjusted, since it depends on the slant and sinuosities of the tube, and this delay of contact gives the selection of the blade, since the operator can send signals which are spaced



DISTANT OPERATION BY HERTZIAN WAVES —RECEIVING DEVICE.

close enough together so that the drops have not time to reach the cap during the instant when the other blades pass by this special angle. When he ceases to send the signals the right blade has now come into place, and after a short time the mercury makes the contact desired. A properly placed commutator on the shaft gives the electric contact at *a* and *f*.

This retarding principle allows of controlling the working device (steering, etc.) A control or check signal shows the operator the exact moment when the right blade has come into the contact angle. In wireless operations this signal can be given from the torpedo, etc., by a transmitter lodged within it, or else a luminous signal can be used, which the operator sees. Since the speed of propagation is almost instantaneous, he is warned in advance that a certain circuit is about to be closed on the torpedo. If he desires to annul the operation which has been commenced, he sends an extra set of signals which causes the wheel to turn before the mercury arrives at the end of the tube, and the contact cannot therefore be made. Foreign wave signals which are not syntonized are obliged to use a certain time *t* of some length, in order to charge the coherer. It is known, in fact, that the coherer charge is equal to the product *C V t*, *V* being the potential, *C* the capacity, and *t* the time in seconds. As *C* and *V* are small, owing to the lack of syntonization, the factor *t* increases, and in practice it always has a value greater than the duration of the delay in the contact.—Western Electrician.

A NOVEL SYSTEM OF WIRELESS TELEPHONY.

In a recent lecture before the Italian Society of Electrical Engineers, Prof. Q. Majorana of Rome describes his system of wireless telephony, which is based on the use of a spark gap, in which the intensity of the electric waves given off is altered in accordance with the sound vibrations striking the membrane of a microphone.

The rotating spark gap used by the professor comprises a motor, on the axle of which is mounted an ebonite disk, carrying, opposite one another, two metal rings, in contact with two metal brushes which are inserted in the discharge circuit. Two steel wires of 2 millimeters diameter are fixed to these rings and terminate in a piece of ebonite, insuring a rigid connection between either of them and one of the two terminal wires. The latter, like the other two wires, are parallel to one another; in order, however, that the discharge may occur between them, their distance has been made smaller. The two wires of the spark gap are connected to the secondary of a statical transformer, the primary of which is connected with the alternating current of the city mains.

Majorana uses an oil transformer capable of absorbing 2 kilowatts and of giving a maximum potential difference of 100,000 volts. In the present case the windings of this transformer are so arranged as to give a potential of only 25,000 volts.

When a convenient capacity (of about 0.0002 micr.) is inserted in the secondary circuit, as soon as the spark gap is rotated, the sparks, under the blowing action of the air, will be separated from one another, giving as many as 10,000 individual sparks per second.

The methods by means of which Majorana has acted

on these sparks include the manometrical flame method and the methods of a vibrating wire in a magnetic field of gas or mercury jets respectively. The best results have, however, been obtained in connection with a method based on the use of a hydraulic microphone invented by Majorana himself.

In wireless telephony, microphones should obviously be liable to respond, not to an alteration in a low-tension current, as in the case of ordinary telephony, but to high-potential discharges, in connection with which a variable contact between carbon flames (as in the case of ordinary microphones) would obviously be without the least effect. The microphone invented by Majorana accordingly is susceptible to stand potential differences of several thousand volts without becoming heated under the action of intensive currents (several amperes).

Majorana's microphone is based on the well-known physical properties of liquid jets. The frequency of the individual drops into which a liquid jet is separated under the conditions of the experiment represent the period of the vibration of the jet. This can be observed by an acoustical method, causing the jet to strike an elastic membrane at the point where it begins to separate, which will give out a sound accurately corresponding to this period. If, however, outside vibrations strike the liquid jet, the latter will perform periodical contractions at a short distance from the mouth. These contractions strictly correspond to the period of the outside vibrations. The membrane accordingly gives out the sound corresponding to this period. If now a plane surface be inserted in the path of the jet at right angles to its direction, the jet will produce a liquid veil of variable thickness according to the vibrations of the jet.

The microphone based on these phenomena comprises, outside of the ordinary mouthpiece serving to concentrate the sound waves, a small glass tube traversed by slightly acidulated water free to move under the action of the vibrations of the membrane.

On issuing from an opening in this tube, the liquid will strike the plane surface of an attachment called a collector, consisting of two cylindrical platinum pieces insulated from each other by a solid insulator. On striking the center of this collector, the liquid jet will be converted into a thin veil, placing the two parts of the collector in permanent electrical connection. A telephone and battery inserted in the circuit of these collector parts will be traversed by a constant current as long as the membrane is not struck by sound vibrations coming from outside, that is to say, as long as the liquid jet does not undergo any contraction. As soon as outside sounds strike the vibrating membrane, the mouthpiece will, however, begin vibrating and the liquid jet will be contracted, corresponding to the sound vibrations. The intensity of the electric current will accordingly undergo periodical modification, resulting in the sounds and words spoken into the microphone being reproduced.

This microphone is inserted in the circuit producing the electro-magnetic waves, and when placed in suitable connection with the rotating spark gap, will serve to modify the intensity of the sparks in accordance with the sound waves and words enunciated before the microphone. These alterations will then reproduce the transmitted sounds at the detector of the receiving station with a perfect truthfulness.

The results obtained with this apparatus have been extremely satisfactory. Majorana has been using, also with good results, the hydrogen arc suggested by Poulsen, in the place of the rotating spark gap described above.

THE DEVELOPMENT OF ARMORED WAR VESSELS.—II.

ARMOR PLATING IN THE UNITED STATES.

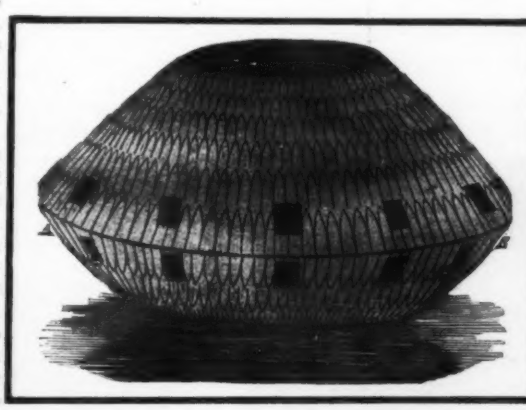
BY J. H. MORRISON.

Concluded from Supplement No. 1652, page 132.

The most valuable paper on iron-clad ships of war at a very early date is considered to have been one written in 1823 by Capt. Montgery, an officer in the French navy. It was commented on by the London Mechanics Magazine in 1824 as follows: "Since the discovery by Mr. Perkins of so vast a destructive power as his steam artillery, it becomes of more importance than ever that nations should learn to make their ships as shot and shell proof as possible. On this subject there is in Ferusae's Bulletin des Sciences Technologiques a memorial of M. de Montgery, a captain in the French navy, which is well worth attention and from which we shall chiefly extract the materials of the present notice.

"The author's object is to recommend the universal adoption of iron instead of wood in the structure of ships. A multiplicity of objects formerly composed of wood are now formed of iron: bridges, arches, aqueducts for public highways, and other objects not so colossal, but very important in their application to maritime affairs, such as wrought-iron tanks and hollow cylinders for masts and yards, and chains in lieu of hempen cables and cordage. But why up to this time have there been so few vessels constructed entirely of iron? Will not mankind at some future period wonder how enlightened nations could have thought of building objects so stupendous and so expensive, with so fragile and so perishable a substance as wood, while they possessed a material to substitute for it so solid and durable as iron? The ordinary term of duration of wooden ships is twenty years; and during that period they must be hove down and thoroughly repaired three or four times. To the duration of an iron ship, on the contrary, it would be difficult to assign any period. Vessels of this description have no need of caulking or copper bottoming. Little subject to leaks, there is the less fear of their running ashore; and still less are they subject to the casualty of fire. The first cost of them might be greater—that we doubt; but from their far greater durability and standing so little in need of repairs the saving in the end would be immense. It deserves farther to be considered that large timber is becoming every day more and more scarce, while from the increased dimensions of new ships more wood is required in shipbuilding. Of iron, on the contrary, the stores are inexhaustible. It may be said that the adoption of iron would serve to uncraft or disqualify a numerous body of men (the shipwrights) and throw them for a time out of employment. A temporary inconvenience to a few ought not, however, to be opposed to a great, general good, considering, moreover, how much the country at large would gain by the increased activity which this new demand for iron would give to our mines, commerce, and agriculture.

"M. Montgery contends that while we have vessels of war constructed of wood, they should at least be plated with iron, and it will be seen from the following passage that he had distinctly anticipated such an application of projectile force as that discovered by Mr. Perkins: 'For more than 350 years it has been in agitation to throw shells from mortars *horizontally* instead of elevating them according to the general practice. The adoption of howitzers in the field of battle, independently of a great number of special experiments, has at length proved beyond doubt the importance of this mode of firing, which it has also been proposed to adopt on board of ships and on marine batteries. Long before anyone had thought of substituting metal for wood in the construction of large vessels' plates of iron or brass had been used for covering ships of war and battering rams. The celebrated galley built by Archytas and Archimedes for Hiero, tyrant of Syracuse, was cased in this way. Philo of Byzantium afterward proposed using battering machines made entirely of metal; but Father Mersenne appears to have been the first who thought of adopting them for ships.'



W. SHIRES' STEAM ARMORED FLOATING CASTLE.

"M. Montgery says that to render the sides of a vessel shot and shell proof they should have a plating of iron about 6 inches thick; that is, a series of sheets of iron with blocks of cast iron between. He conceives that the blocks would only be necessary in the parts exposed to the fire of the enemy, and that there would be no occasion for them toward the keel of the vessel."

The first record found of an English proposal for a war vessel that was to be protected by iron is in the same mechanical journal, but of 1827, describing a "Floating Castle to go by steam, and to resist balls." The specifications of this proposal are: "The base of the castle is to be made of plank and to rest on flat-top boats, forming a common deck to them all, to which the boats are to be made fast. The side to be built in substance and quality like that of a man-of-war, and to be shielded with iron and steel plates. All the plates above the ridge to point upward, and those below it downward, so that they may deflect off all balls directed against the structure. The top is to be left open; but being above the horizontal range no ball can enter by it. The several steam engines and rudder by which the castle is to be conducted are to act within it through openings made in the bottom of the castle betwixt the boats; hence the acting part cannot be destroyed by shot. The lower guns are designed to fire at the hulls of ships, while the upper guns cut away the masts, rigging, etc. Castles thus made, each to cover an acre of ground, would carry ten thousand men with provisions for two months, and no doubt would be found better in practice than any other machine for a like purpose."—(Signed) W. Shires.

That the use of iron for the protection of wooden war vessels had not passed from the minds of American inventors at this time we have evidence of in the memorial presented to Congress in 1828 by Uriah Brown, of Baltimore, Md., "relative to a system of harbor and coast defence of the United States by means of impregnable and invincible fire ships." While this petition failed to be met with any action in its favor through legislation there were a few items of interest in the specifications of the vessel showing that iron plating had again been entertained by progressive men. The Secretary of the Navy in his report on the proposed vessel says in part: "The construction of the vessel of a sufficient thickness to render it impervious to the shot of an enemy, of a capacity to contain the whole machinery, with men, fuel, etc., and covered with sheet iron to prevent combustion, appears well calculated upon the principles of an inclined plane to reflect any shot at any possible angle at which they can be fired from a ship to be assailed." This proposed vessel was further described by a military expert of that day: "The plan of this vessel was predicated on the principle of inclined planes, and calculated to resist the shot of an enemy by reflecting them at any and every angle at which they might be directed by the ship to be assailed. The size of the vessel was calculated to be 125 feet in length and 50 feet in breadth, and to be propelled by steam power."

Even though there had been a desire in this country at this later period to design a vessel that should be protected with iron plate, it is altogether improbable that the plating could have been obtained in this country that would have been of good service for such a purpose, though it may have been obtained at the time, or a little later, from Great Britain. The subject appears to have gradually dropped from view, and it was several years before it came to be considered again of any moment. One of the reasons that may be assigned for this condition existing so many years would be that after 1824 when all barriers to the free navigation of the rivers of the United States were removed by the decision of the Supreme Court of the United States, a more extensive field was opened than had existed prior to that date for the inventive powers of those drawn to marine objects, and for several years the increase and improvements of our merchant marine occupied the best thought and talent of the country. The designing of labor-saving machines, the improvement of the old style of tools in our work shops, and the better methods devised of constructing a vessel, as well as building the machinery, claimed the attention of the American mechanic and the inventor for all these years. Their labors were expended in the development of the tools of a peaceful commerce, in place of designing improved types of engines of war for destruction. The country had enjoyed a long period of peace with all foreign

nations, and "war talk" being at a discount, there was no demand for an advanced type of naval vessel.

It was at the time that Congress, in 1835, had authorized the construction of an armed steam vessel for the navy that there was laid before that legislative body the design of an iron-clad vessel by Clinton Roosevelt, of New York city. The description of the proposed vessel says: "It is rendered invulnerable by making the bow and stern of the vessel alike sharp, and plating them with polished iron armor, with high bulwarks and a sharp roof plated in like manner, with the design of glancing the balls, which can be done if the angle of incidence be sufficiently acute. The means of offense are a torpedo which is made to lower on nearing the enemy and be driven by a mortar into the enemy's side under water, where by a fusee it will explode. There is also a very large cannon at each end of the battery, to use in case circumstances should render an attack by the torpedo impracticable. The mode of approach is always to keep one of the ends of the battery opposed to the enemy. There are means to prevent balls from reaching any part of the machinery." The measure received but little attention at the time, as the vessel was of too radical a type for that day. Iron-hull steam vessels were just at this time being subjects of experiments on the Savannah River in the transportation of cotton and other Southern products to the seaboard, and the good service performed by these vessels brought out most prominently the value of iron in the construction of the hull of a vessel.

When the naval steamer "Fulton" was under construction at the Brooklyn navy yard in 1836, it was suggested to the Board of Navy Commissioners that the engines and boilers of the vessel be protected from hostile shot by inclined bulwarks *to be covered with iron*. It failed to meet the approval of that august body. The plans for the vessel had been approved by the board and changes could not be made.

THE RISE OF MAN.*

A STUDY IN EVOLUTION.

THE Christian religion is the only widespread belief that has incorporated in it the idea that man is of direct divine origin. To the Hebrew faith, crystallized to its present form even at the beginning of our era, the thought of attributing offspring to God was repulsive. Even Mohammed emphatically asserted that "God is neither begotten nor a begetter."

On the other hand, the Greeks held the thought of divine descent, and it was the Apostle Paul, who, by quoting to the Athenians the line from the Greek poets—

"For God's offspring are we,"

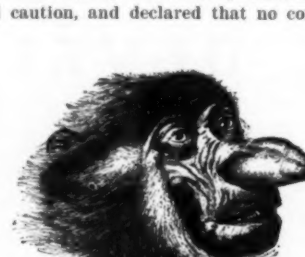
gave to the Gentile Christian Church the impulse that caused it to interpret in so different a manner the Hebraic legend of the creation of mankind from the clay. To this interpretation can be traced the bitter opposition that met Darwin when first he enunciated his doctrine of "evolution" and the kinship of man to the rest of the animal creation.

Although "evolution" in its original sense of an unfolding from a latent condition to an open and visible form, is without doubt inexact, a meaning more in accordance with observed facts has since solidified around the word. We now use the term instead of "epigenesis" since it is now an accepted fact that development is due to the effect of external sensations rather than to inherent tendencies.

The inference that man is descended from the apes raised another barrier to the popular acceptance of Darwinism, for in spite of their many human qualities, they inspire more or less disgust in the thinking mind. In the most notable examples of this resemblance, the proboscis monkey, the similarity is found to be merely superficial and not to have any anatomical foundation. Few other monkeys strongly resemble human beings.

Of the higher apes, the orang-outang is in a group by himself, while the gorilla and the chimpanzee are closely related. In spite of the close anatomical and physiological relationship between the chimpanzee and man, scientists now hold that they are no more closely akin than would be any other forms of life descended from a common ancestor, but brought up under different conditions for long periods of time.

After Brehm.
(Haeckel's Anthropogenie, p. 607.)



After Wiedersheim.
(Weltall und Menschheit, II. 145.)

HEAD OF PROBOSCIS MONKEY.

Where man originated is a vexed question. Many naturalists point to the sunken continent in the Indian Ocean which reached from Australia on the east to Madagascar on the west, including the Sunda Islands. It is here, they say, that conditions were the most favorable for the support of a primitive race, and it is true, remains of a remarkably low form, the ape-man of Du Bois, were found in Java. Yet it is in the rougher northern climate, where the problem of life was harder, that we must look for the rise of mankind. That the warm climate of Australia, a country free from dangerous animals, was not conducive to development, is shown by the fact that very nearly the lowest known race lived there even in recent times; a race still in the paleolithic stage.

A RESTORATION OF THE NEANDERTHAL MAN.

This picture is a retouched photograph taken of a model made by Guernsey Mitchell according to the instructions of Prof. Henry A. Ward of Chicago.

In the year 1857 a human skeleton was discovered in a limestone cave in the Neanderthal, near Domap. A hot controversy immediately ensued. Virchow advised caution, and declared that no conclusions could be drawn from one isolated instance, for the bones under discussion might belong to a degenerate or to an imbecile. It was not until other skulls, also nearly approaching the human type, had been found that the likelihood of the existence of a mutual ancestor of man and the apes was admitted.

In the Neanderthal skull, the occiput is well developed, while the forehead is low and narrow, and still possesses the orbital ridges of the lower animals. The facial angle is but 62 deg., not much greater than that of the higher apes. (The average facial angle of the human race to-day is between 80 deg. and 85 deg.)

Judging from his bones, the Neanderthal man must have been a strong creature, while the injuries they show would indicate that he must have been a ferocious fighter. The left ulna, for instance, received an injury that healed during his lifetime, to be sure, but which must have prevented the full extension of the arm. The right parietal bone of the skull is the seat of a cicatrized wound, evidently inflicted with some sharp instrument. A groove in the right superciliary ridge is another abnormality, no doubt caused by a violent blow which must have caused an ugly gash over the right eye. Building upon these facts, the restoration shown in the accompanying illustration was made.

The *Pithecanthropus erectus* Du Bois was discovered in tertiary drift on the banks of the Bengawan River, in Java, during the year 1891. The find consisted of a cranium midway between that of man and the simians, a molar tooth of great breadth, but unmistakably human, and a femur of peculiar straightness. This last characteristic caused Prof. Du Bois to add the qualifying term "erectus." It has been pointed out, however, that the typically human bone always possesses a slight curve, so that it is not improbable that this form may have been nearer the apes in his walk than his discoverer realized.

The skull of the Pithecanthropus is of reasonably great length and breadth, but its height is extremely low. The processes for the attachment of the back muscles at the rear of the skull indicate a very stocky neck not unlike those of the anthropoid apes. Although the former existence of this interesting type is established beyond a doubt, not enough data is possessed to work up details, or to determine the time interval between the first appearance of this species and the appearance of primitive man.

The differences, lying largely within the frontal region, between the skulls of primitive man and the skulls produced under the conditions of modern civilization are not so marked as one might expect. The increase in height of the cranial dome has been very slight, as compared with the enlargement of the frontal portion. This is no doubt due to the fact that although primitive man had little need for his reasoning powers in combating the dangers of his crude existence, his very life depended upon a well-developed memory and the other qualities that are seated in the anterior part of the brain. In the early days, life

* The Rise of Man. By Paul Carus. Illustrated. The Open Court Publishing Co. Chicago, 1907. Octavo. Pp. 97.

must have been quite as difficult and complex as it is to-day, for the very reason that it was less highly specialized. Under the present conditions, an individual who can do one thing reasonably well is practically sure of success in the struggle for existence. Under the conditions existing when the race made its appearance, however, man was obliged to be a "jack of all trades." He first had to be a strong and cunning fighter, his next need was of skill in hunting, and lastly, he had to be at least a passable artisan in the making of the few utensils he needed.

From this it can be seen that our development under civilization is no more rapid than it was under the crude necessities of savagery. We seem to make greater strides, it is true, but it is only because we have a greater body of past experience to draw upon. Perhaps the greatest change is that instead of the distribution between the "fit and the unfit" being, life for the one and death for the other, as formerly, the "fit" now succeed in their chosen lines of activity, while the "unfit" are thrust to lower levels.

TOMATOES THAT IMITATE FRUIT.*

THE ECCENTRICITIES OF A COMMON VEGETABLE.

BY I. M. ANGELL.

The tomato family possess the quality of imitation to a remarkable degree. Each one of twelve fancy varieties raised in our garden last season resembled some sort of fruit.

One of the accompanying photographs shows a cluster of Burbank Preserving tomatoes and a bunch of grapes. The size, shape, and arrangement on the stem are very similar, but the color of the tomatoes is the ordinary bright red. This sort is spoken of in the cyclopedia as the "cherry-like exquisite-flavored Burbank Preserving tomato." We did not find them particularly attractive in the raw state, but in any case they are worth raising, as a curiosity. The plants are very strong, but smaller than the common tomato and may be set closer.

Another photograph shows a group of small Seckel pears and some pear tomatoes. These average nearly two inches in length and keep very true to the pear shape. There are both yellow and red varieties, the former being the more useful of the two, because of its good flavor and the preserves and confections made from it. Pear tomatoes are very productive, yielding nearly two hundred to the plant. The pear sorts, or in fact any of these small tomatoes, either yellow or red, are very good stewed. Scalding will loosen the skin, which may be easily popped off without peeling.

California cherries and beside them some yellow cherry tomatoes are also illustrated. The resemblance in size and shape is very close. It is easy to imagine a similarity in flavor also, as these small-fruited tomatoes have more sweetness than the large ones. The red cherry is larger in size and somewhat like the Burbank Preserving tomato, though better flavored for eating raw. It is also remarkably productive, one plant bearing 270 tomatoes.

The resemblance between a peach and two peach tomatoes is even more noticeable in another variety. The shape is very peach-like, the skin is tender and easily torn, like the fruit itself, and there is even a downy surface, not unlike peach skin and very unlike the hard shiny skin of the common tomato. The color, too, is suggestive of peaches, being shaded and streaked as if in imitation of the fruit. Yellow peach tomatoes are like the red ones except in color, being so light they do not show any likeness to the fruit itself. Peach tomatoes proved to be the most interesting and useful of all the fancy sorts. For eating from the hand they are excellent, the flavor being sweet and fruit-like. They stand a wet season well and have been found very satisfactory for canning. In the green stage they are one of the best sorts for pickles. They are early, continuous, and late bearers.

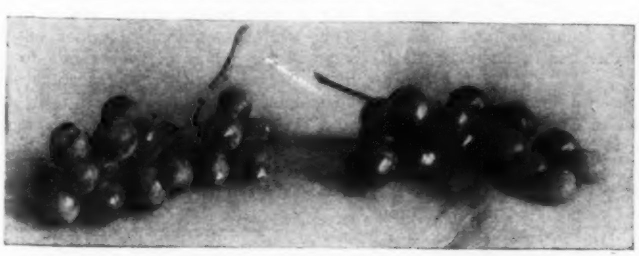
One illustration shows an apple tomato compared with an apple. This sort is rounder and firmer than most of the tomato tribe and so shows closer resemblance to an apple. The color is so pale a yellow as to be almost white. They are not of much use, being insipid in flavor and only attractive as a curiosity. These are not specially recommended for table use.

Plum tomatoes and plums are wonderfully alike in size and shape, but differ in color and bloom. There are both red and yellow plum tomatoes, the latter being the most commonly seen of all the fancy sorts. They are well flavored and very productive, over 250 being taken from one plant.

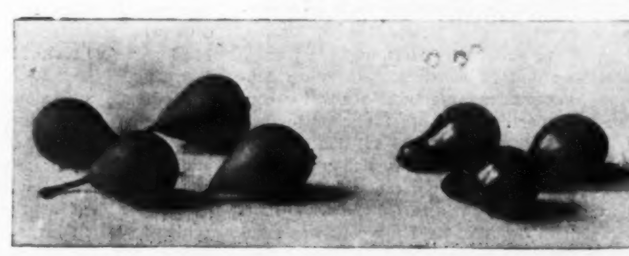
One of the illustrations pictures a dish entirely made

* From American Homes and Gardens, published by Munn & Co.

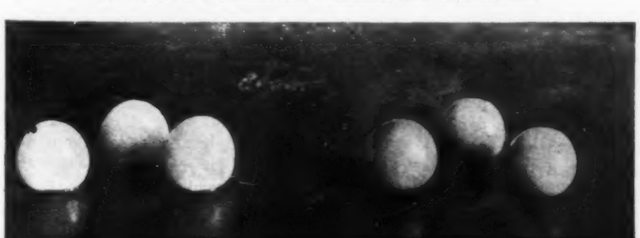
A DISH OF TOMATO FRUIT.



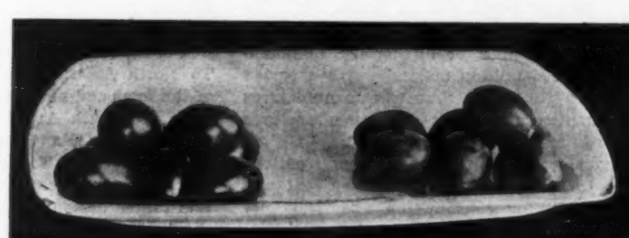
GRAPES AND BURBANK PRESERVING TOMATOES.



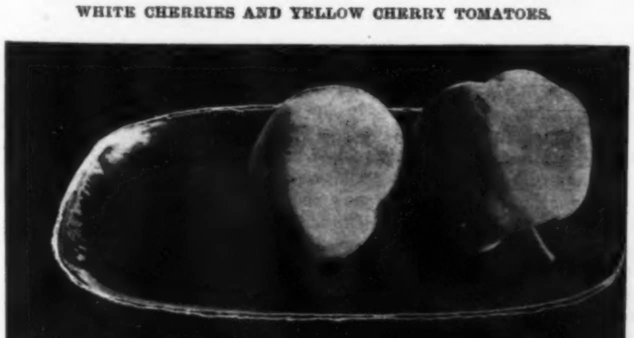
SICKEL PEARS AND PEAR TOMATOES.



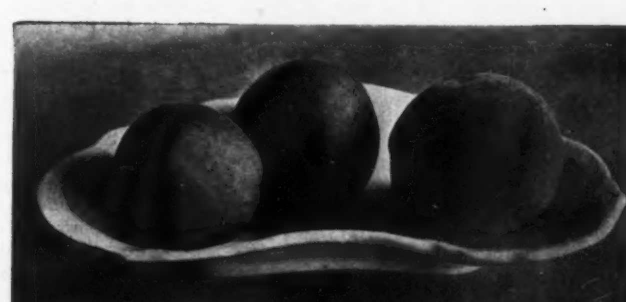
WHITE CHERRIES AND YELLOW CHERRY TOMATOES.



PLUMS AND PLUM TOMATOES.



AN APPLE TOMATO AND AN APPLE.



A PEACH AND TWO PEACH TOMATOES.

TOMATOES THAT IMITATE FRUIT.

up of tomatoes that resemble fruit. The larger ones are peach and apple tomatoes, the medium-sized ones are plum, cherry, and pear tomatoes, and the smallest of all are currant tomatoes, a non-edible sort, growing on a "string" like currants and having a bright-red color. When full sized they are only three-eighths of an inch in diameter. On the table beside the dish is a bunch of "grapes."

Another sort that makes an attempt at imitating fuit is the strawberry tomato. This does not resemble the original in either shape, size, or color, but, when cooked for the table, the flavor is much like canned strawberries. This sort is very easy to grow and self sows. The fruit may be stored in its husks and kept till almost mid-winter in a cool dry spot. It is recommended for pies and to dry for use in cakes.

As well as supplying an object of interest in the garden these fruit tomatoes will be found very useful for various sorts of preserves and pickles, recipes for which are seen in numerous cook-books. The yellow pears are scaled, skinned, cooked with sugar, and dried. The yellow plums are quite commonly used for preserves, with sugar, lemon, and ginger root. Any small fancy tomato in the green state makes attractive pickles, put up whole, first pricking with a pin to prevent bursting, and pickling in vinegar with nasturtium seeds. Any of the yellow sorts make a good marmalade, cooked with sugar and grated pineapple. Tomato honey may also be made from any of the yellow kinds. They are combined with lemon and sugar, cooked, strained, and cooked again till thick. Any sort of fancy tomato makes excellent chopped pickles when used green. Having more skin in proportion they chop more firmly and keep their shape better than the larger sorts which are apt to become mushy.

Some of these curious tomatoes should be grown in every garden. Even a sunny city yard need not despair of a good crop, for tomatoes do not require rich soil, and they may be grown on very little space if trained to a tall trellis, which will have the further advantage of providing a screen. A six-foot trellis will accommodate a tomato plant to each running foot. About a month after setting out the plants, pruning should begin and be kept up till toward the end of the summer, when the most vigorous growth ceases. Two or three lengthwise stems will be enough to leave for each plant; the rest should be cut off, also all growth below the first blossom cluster.

It is not often that plants of the fancy tomatoes can be bought. Any would-be gardener with a sunny window may raise his own. The smallest pinch of seed of each kind will be more than enough. A dozen two or three-inch pots will start the whole collection of odd tomatoes. When two inches high they require more space. Those mentioned in this article were sown from March 29 to April 11, which gave sufficiently early returns for an ordinary home garden. Seed sown outdoors May 1 produced ripe tomatoes in September, and some sown as an experiment, July 4, gave tomatoes of pickling size in October. The season may be lengthened almost to the holidays by hanging the vines in a sheltered place when frost comes, or laying the unripe but full-sized fruit in a drawer or closet.

Young tomato plants are damaged by too much moisture, but a lack of it, when they are forming fruit, will give wrinkled and poor shaped tomatoes. The fancy sorts grow in clusters of a dozen, more or less; this adds to the attractiveness of their appearance and causes them to be easily picked.

SHARE WHICH MANUFACTURES FORM OF THE EXPORTS TO THE VARIOUS SECTIONS OF THE WORLD.

THE large share which manufactures form in the exports of the United States to all parts of the world except Europe is shown by an analysis just completed by the Bureau of Statistics of the Department of Commerce and Labor of the trade, by articles and groups of articles, with every country and grand division of the world. These figures show that manufactures formed 86 per cent of the exports to South America in 1906, 85 per cent of the exports to Oceania, 75 per cent of the exports to Asia, 66 per cent of the exports to Africa, 62 per cent of the exports to North America, while even to Europe manufactures formed 27 per cent of the total domestic merchandise sent in the fiscal year 1906.

This general group, "manufactures," upon which the above percentages are based, includes both manufactures ready for consumption and manufactures for further use in manufacturing. The first group includes all manufactures in the fully completed form and ready for immediate use. The second is made up chiefly of chemicals, leather, naval stores, lumber, copper in pigs, bars, and ingots, and various grades of iron and steel which have passed through a process of manufacture but are to be further used in manufacturing, such as steel bars, billets, ingots, blooms, sheets and plates, tin plate, wire rods, and pig iron.

Of the 75 million dollars' worth sent to South America, 72.04 per cent was manufactures ready for consumption and 14.02 per cent manufactures for further use in manufacturing. Of the 105 million dollars' worth sent to Asia, 65.79 per cent was manufactures ready for consumption and 9.14 per cent manufactures for further use in manufacturing. Of the 35 million dollars' worth sent to Oceania, 72.97 per cent was manufactures ready for consumption and 11.78 per cent manufactures for further use in manufacturing. Of the 20 million dollars' worth sent to Africa, 58.79 per cent was manufactures ready for consumption and 6.85 per cent manufactures for further use in manufacturing. Of the 295 million dollars' worth exported to North America, 50.46 per cent was manufactures ready for consumption and 11.37 per cent manufactures for further use in manufacturing. Of the 1,189 million dollars' worth of domestic merchandise sent from the United States to Europe in 1906, 12.72 per cent was manufactures ready for consumption and 14.06 per cent manufactures for further use in manufacturing.

Thus, more than one-half of the domestic merchandise sent out of the United States to each grand division except Europe goes in the fully manufactured form, ready for consumption; in the case of South America and Oceania practically three-fourths, in the case of Asia practically two-thirds, and in the case of North America practically one-half goes in the fully manufactured form.

Taking up the principal countries, the figures of the Bureau of Statistics show that 11.85 per cent of the exports to the United Kingdom was manufactures ready for consumption and 11.23 per cent manufactures for further use in manufacturing. Of the exports to Germany, 10.98 per cent was manufactures ready for consumption and 12.96 per cent manufactures for further use in manufacturing. To France, 12.67 per cent of the exports was manufactures ready for consumption and 18.44 per cent manufactures for further use in manufacturing. To Canada, 48.8 per cent of the exports was manufactures ready for consumption and 13.1 per cent manufactures for further use in manufacturing. To Mexico, 58.77 per cent was manufactures ready for consumption and 11.61 per cent manufactures for further use in manufacturing.

To Cuba, 45.94 per cent of the exports was manufactures ready for consumption and 9.31 per cent manufactures for further use in manufacturing. To Argentina, 79.93 per cent of the exports was manufactures ready for consumption and 18.67 per cent manufactures for further use in manufacturing. To Brazil, 72.9 per cent of the exports was manufactures ready for consumption and 10.24 per cent manufactures for further use in manufacturing. To Chile, 74.82 per cent of the exports was manufactures ready for consumption and 10.71 per cent manufactures for further use in manufacturing. To China, 85.12 per cent was manufactures ready for consumption and 10.65 per cent manufactures for further use in manufacturing. To Japan, 45.89 per cent of the exports was manufactures ready for consumption and 10.28 per cent manufactures for further use in manufacturing. To the Philippine Islands, 59.75 per cent of the shipments was manufactures ready for consumption and 9.13 per cent manufactures for further use in manufacturing. To Australia, 76.48 per cent was manufactures ready for consumption and 12.26 per cent manufactures for further use in manufacturing.

Foodstuffs and manufacturers' material formed the larger share of the merchandise sent to Europe and a considerable percentage of that sent to North America, while to the other grand divisions neither foodstuffs nor raw material for manufacturing form any considerable per cent of the total. To Europe, foodstuffs (chiefly wheat flour, corn, and meats) formed 36.3 per cent of the total merchandise sent in 1906, while raw material for use in manufacturing (chiefly cotton) formed 36.83 per cent of the total, the remainder being, as above indicated, manufactures ready for consumption or manufactures for further use in manufacturing. To North America, foodstuffs formed 20.23 per cent of the total and manufacturers' raw material 16.12 per cent. To South America, foodstuffs formed 13.32 per cent of the total and manufacturers' raw material less than 1 per cent. To Asia, foodstuffs formed 13.83 per cent and manufacturers' raw material 11.2 per cent, this larger percentage of the raw material being due chiefly to sales of raw cotton to Japan. To Oceania, foodstuffs formed 9.65 per cent of the total and manufacturers' raw material 4.96 per cent. To Africa, foodstuffs formed 28.39 per cent of the total exports and manufacturers' raw material 5.86 per cent.

Taking up the analysis by countries, the figures show that of the exports to the United Kingdom 34.07 per cent was crude materials for use in manufacturing; 27.29 per cent foodstuffs partly or wholly manufactured, including in this group flour, meats, dried and preserved fruits, etc.; 15.46 per cent foodstuffs in a crude condition, and food animals; 11.23 per cent manufactures for further use in manufacturing, and 11.85 per cent manufactures ready for consumption. Of the exports to Germany, 48.28 per cent was crude materials for use in manufacturing; 19 per cent foodstuffs partly or wholly manufactured; 8.65 per cent foodstuffs in a crude condition, including food animals; 12.96 per cent manufactures for further use in manufacturing, and 10.98 per cent manufactures ready for consumption. In the case of France, 55.38 per cent of the total was crude materials for use in manufacturing; 5.52 per cent foodstuffs partly or wholly manufactured; 7.96 per cent foodstuffs in a crude condition; 18.44 per cent manufactures for further use in manufacturing, and 12.67 per cent manufactures ready for consumption. In the case of Canada, 24.39 per cent was raw materials for use in manufacturing; 4.74 per cent foodstuffs partly or wholly manufactured; 6.23 per cent foodstuffs in a crude condition, and food animals; 13.10 per cent manufactures for further use in manufacturing, and 48.8 per cent manufactures ready for consumption.

Summing up this study of the share which manufactures formed of the exports to the principal countries and grand divisions in 1906, the figures show that 151 million dollars' worth of manufactures ready for consumption went to Europe, 149 million dollars' worth to North America, 69 million dollars' worth to Asia, 54 million dollars' worth to South America, 26 million dollars' worth to Oceania, and 11 million dollars' worth to Africa; while of the manufactures for further use in manufacturing 167 million dollars' worth went to Europe, 33 millions to North America, 10 millions to South America, 10 millions to Asia, 4 millions to Oceania, and a little over 1 million dollars' worth to Africa. Thus while manufactures formed but a comparatively small percentage of the exports to Europe because of the large quantities of foodstuffs and raw material demanded by that continent, they actually aggregated a greater sum than the manufactures sent to any other of the grand divisions, though in the other cases the percentage which manufactures formed of the total was much larger than in the trade with Europe.

PHOTOGRAPHIC PLATE TESTING.

MR. R. JAMES WALLACE, of the Yerkes Observatory, has recently made various suggestions with regard to the sensitometry of photographic plates, that form a valuable contribution to this subject. For general sensitometry he finds that the best approximations to a standard artificial light suffer from many disadvantages that diffused daylight is free from when the sensitiveness to daylight has to be estimated. He therefore employs diffused light from the northern sky when the sun's altitude is at least 15 deg., and allows this to pass through thin "milk glass." Having no standard intensity, he adopts a standard plate instead, and finds the "Seed 27, gilt edge," the most suitable. A part of one of these is exposed with the plate to be tested in a graduating apparatus, and the results are compared after the general manner of Hurter and Driffield. He measures the densities with a spectro-photometer, but not the same as was adopted by Mees and Shepherd. For color sensitiveness he discards colored media in favor of spectroscopic methods. But as glass prisms give abnormal dispersion and show very much selective absorption, they are not used. Original gratings, ruled in speculum metal, also show selective absorption, which varies with the condition of their surface and the tarnish that comes with age. The celluloid replica gratings are free from these drawbacks; he therefore proposes these as standard dispersion pieces, and to insure uniformity he generously offers to send one to any known worker who has use for it. These replicas are of very fine quality. They are all prepared in exactly the same way, with the same celluloid solution, from the same

original, and mounted on glass of the same refractivity. The pattern of spectroscope suggested is of simple form, about 20 inches long, with two achromatic lenses of 12 inches focal length, and a moving plate carrier, so that several spectra, giving different exposures, may be taken on one plate. He suggests giving the density at, say, six points in the spectrum obtained, to indicate the color sensitiveness of the plate tested.

There is a great deal that one would like to say about the above suggestions. The adoption of the replica grating can perhaps hardly meet with anything but warm approval. But to adopt any commercial plate as a standard of sensitiveness, though it may be more advantageous than the use of any standard light yet proposed, cannot be regarded as satisfactory. We must seek for something still better. It is very doubtful whether a standard plate is possible at all, for although plates keep in usable condition for many years, there is little doubt that they all change continuously from the moment they are made.

The spectro-photometer may be regarded as an undesirable instrument for measuring opacities. The light that is scattered during its passage through the photographic plate is largely lost and the proportion scattered is variable. The dispersion introduces fresh sources of error, leads to loss of light, and appears to offer no advantage. Much simpler apparatus can be made that will eliminate the dividing line between the two patches of light that are being compared, a point specially emphasized by Mr. Wallace, and that will be free from the disadvantages pointed out. A large proportion of the measurements that have been made since Hurter and Driffield introduced their photometer have not been measurements of opacity (or density), as they have been stated to be, because of the loss of an uncertain amount of the variable proportion of the scattered light. It seems a pity to use apparatus that suffers from this radical defect, and to introduce disadvantageous complexities. — Chapman Jones, F.I.C., in Knowledge and Scientific News.

MOSQUITO EXTERMINATION WORK.*

AN ACCOUNT OF WORK IN MASSACHUSETTS.

BY HENRY CLAY WEEKS.

ECONOMIC entomology has no more signal triumph to attest its importance and usefulness than that of mosquito extermination, for it is to the entomologists, primarily, is due the remarkable crusade that is in progress in various parts of the world against the evils of this pest. An indication of this widespread interest is strikingly shown in the location of the most recent members of the American Mosquito Extermination Society—Sydney, N. S. W., Australia; Memphis, Tenn.; New York city; State Board of Health, Florida; Baltimore; Argentine Republic, South America; Toronto, Canada. In probably all of these instances the connection with the society is sought in furtherance of public work against the mosquito through the information given in its own and other literature which it distributes.

We all know of instances of work in very remote sections of the world where remarkable success has been accomplished along lines laid down by entomological investigations, but the purpose of this paper is to outline a single movement here in the State of Massachusetts, so that it may serve as an example and precedent for other sections.

The coastal region of a country, by reason of the extensive tidal streams and their resultant conditions, are generally badly infested with some of the most troublesome of the whole group. These are generally designated as salt marsh mosquitoes—a fine type of which is *Culex sollicitans*. And where a coast country is low-lying, as in the case in point, namely, Cape Cod, the tidal streams enter the interior much further than in a rugged shore line, and in their high stages develop the greater number and extent of breeding places. So that this attractively situated stretch of land, which is swept by ocean breezes in every direction and should therefore be extensively sought by refugees from the heated mainland, has become famed for its vast crop of mosquitoes, rising from its extensive marshes and becoming active agents in retarding the population of the cape. In a recent visit to the scene of the proposed work, Sollicitans were more numerous than would seem possible. "Clouds of them" properly expresses their myriad numbers. Every exposed part of the body and many parts thickly covered with clothing burned as if scorched with fire during the inspection and for hours afterward.

To attack such a situation with assurance of permanent success is indeed a problem worthy of the mettle of heroes, confident of the justice and practicability of their cause.

But just such a move, involving radical measures, is under way in the humble fishing hamlet of Wellfleet, on the cape, having a population in the whole town of less than a thousand souls. Its procedure is worthy of careful study and imitation by more able sections of the country.

Four years ago, some slight work was done on fresh water ponds about the village, with oil only, costing the town a few hundred dollars. This was continued on the marsh parts, with some drainage added, at an outlay of $600 three seasons ago during the whole summer. In 1905, $850 was spent. The result of this oiling, and superficial drainage work, clearly demonstrated to the people that mosquitoes could be very perceptibly decreased. And this, by the way, is the very important result gained by petrolizing. It is the pioneer idea which in all great reforms precedes the permanent attack. Its effect is highly educational, drawing attention to the life habits of the pest. For this reason no greater mistake can be made than in decrying the use of oil. Of course all acknowledge that a battle with oil alone has to be continuous. However, oil always will have its use in such places as, from various reasons, cannot be attacked in a radical way. Its discovery for these uses, or rather rediscovery and application by an entomologist, Dr. L. O. Howard, of Washington, is therefore the initial, and a most valuable contribution to the cause.

Encouraged by a good beginning, the pioneers in the work at Wellfleet, seeing that complete success must entail different measures, sought expert advice. Some had already joined the American Mosquito Extermination Society and had been further encouraged by its reports of successful work elsewhere. A visit to the town two seasons ago revealed a very great exposure in its surrounding marshes. They were on every side and their output was immense. The pests flooded the town and threatened its very life. People were driven from its picturesque hills and valleys, dotted with lakes, not to return, as they said they desired to do, until the mosquitoes were gone.

The conditions were such that the case was getting worse. Small reclamations for agricultural purposes, made scores of years before, were relapsed and their last state was worse than their first, as generally is the case. The tidal streams had become silted or choked and left the waters in distant reaches stagnated. There was not enough descent in the streams and there was but little water from fresh sources so as to keep the outlets clear, and these outlets were therefore so shoaled that the water which entered distant stretches did not have time for egress between tides. These water courses entered for miles into the interior and were so quiet that breeding was favored over about twelve hundred acres of marshes and their brood spread over probably thrice as great an area. Evidently this was a case where oiling and the making of simple ditches would not answer—the area and the conditions were too extensive for the use of oil and there was not sufficient descent in the long distances for draining out any slight ditches into lower levels of water as the courses were constantly too full. Besides, here, the land was needed for agricultural purposes which requires that the level of standing water shall be at least from eighteen to thirty-six inches below the surface. Moreover, the ditches prevent agricultural operations to a greater or less degree.

An inspection and study many days at Wellfleet revealed the source of most of the trouble to be Herring River, which injuriously affected with its flooded area about a third part of the acreage of the town. It ran tortuously northeasterly about five miles and spread by tributaries on each side four and a half and three and a half miles over a broad, irregular territory.

The recommendation was that this river be diked at its mouth and that in the dike there be set outlets for the inner water to escape, in which outlets should be placed automatic gates so hinged as to shut out the high tides of Wellfleet Bay and yet to allow the escape of the inner water when the tide was low. There was to be a run left in the dike for herring to go up the river as always heretofore. This plan would lower the level of the inner water about three and a half feet and would make it possible thoroughly to dry out and cultivate all the interior marsh area the soil of which is an accumulation of leaf mold from the tree-denuded adjacent hills, mingled with the decaying vegetable and mollusk life—a most valuable soil for crops and vegetables. Incidentally the dike is to form a road to adjacent parts now quite inaccessible and thus to open up thousands of building sites at present, and for years past, deserted.

The people of the town generally saw the great advantage to accrue to the tradesmen, to the farmers, and to the landowners, in fact to every interest of the place. Various public meetings after the initial one put the matter before them from a different view point and no objection was raised at any stage but what was promptly answered by different specialists. Dr. Field, chairman of the State Fish and Game Commission, showed how the fishermen would not be injured but rather greatly benefited; engineers explained their plans and the effects of the work on the harbor; Dr. Elwood Mead, of the Department of Agriculture, Washington, personally visited the situation and indorsed the whole recommendation as a drainage proposition which would advance very greatly the agricultural prospects.

Meanwhile legislation was under way to authorize and for financing the movement by town and State appropriations. This has taken the last two years to accomplish but so thoroughly has it been done that the present week sees printed the call for bids on the work and the consent of virtually all of the landowners affected—a prerequisite of the bill passed by the recent session of the Massachusetts Legislature. The little town accepted the authority to bond, and now bonds itself for $10,000 payable within twenty years at about the same outlay as the unending work they were previously doing yearly.

The joint legislative committee of harbors and public lands inspected the situation and approved the idea and both committees of the Legislature on ways and means studied and also approved, and the bill was passed without any dissent. The issue was the dominant one in the election of a member of the Legislature from the district which included the town.

The work planned and provided for will stand for all time and represent a valuable investment and an asset of the town ever continuing to pay large returns in public comfort, attractiveness of the section, in healthfulness and increasing property values. The large uniquely situated hotel on the end of a long pier running out into Wellfleet Bay has been closed for two seasons solely because of the mosquito pest. Its owner, maintaining it in the interest of the birthplace of many generations of his family, is a firm believer in the plans so far wrought out by much hard work, and proposes to open the inn next season—meantime extensively advertising, as one of its many attractions, "No mosquitoes," notwithstanding at present they are the subject of remark at every casual meeting—are in everyone's mouth, eyes, ears, and epidermis. Is he justified in his promise? We answer unqualifiedly "Yes," as to any bred in the vast marshes affected by the work to be completed this fall and we answer substantially "Yes," as to any that may be produced in adjacent breeding places, which it is expected owners and others will redeem later. In fact, the town has already appropriated $1,200 to build a dike at a marsh of 125 acres on the south.

A few instances will be cited which encourage this belief in relief. Through work done by the speaker at Center Island, in Oyster Bay harbor, L. I., in 1902, the island, which was always fearfully infested with the pests though it had extensive and fruitful *Sollicitans* breeding grounds about a mile distant, had its residents, for the first time, able to enjoy lawn and piazzas day and night and continue to do so to the present.

In the case of Lawrence, on the south side of Long Island, the town is built on a low peninsula surrounded by salt marshes for miles. Work has been done there for some years in ditching and oiling and so successful is it that the town has continued willingly to vote $1,000 a year—though at first the idea was opposed at the polls. The work is extended outward each year, but there are still untouched areas breeding very extensively and yet the town is almost free.

The same has been found true in work in other sections on Long Island, in New Jersey, and other places. Of these we frequently have reports showing the great advantage of local work though exposures are not very distant.

Our society some months ago sent a circular of

* Paper presented at the Triennial International Congress of Zoology at Boston, August, 1907, by Mr. Weeks.

inquiry to all the steamship companies whose vessels closely passed the Jersey coast in their courses, asking them to request their captains to report whether they have found any mosquitoes in their trips. Their extensive replies were almost entirely negative, a couple only saying that very occasionally they have observed a few mosquitoes in such passages. And thus this practical test of the truth of the story of the great swarms of mosquitoes off the Jersey coast seems to be disposed of.

We therefore have confidence in urging upon the people of Massachusetts and the country generally the idea that local work is of greatest importance, and should not be deterred by fears of invasions of migratory mosquitoes which are infrequent and do not last.

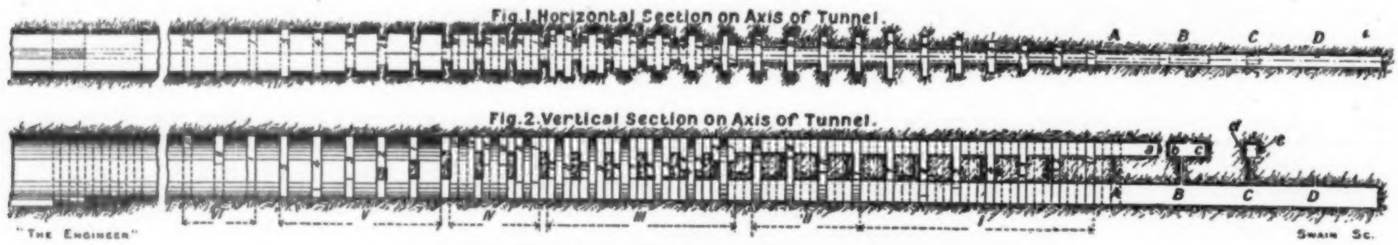
Five years ago, before the State Sanitary Association, we urged the State of New Jersey to undertake the work of extermination in the whole State, and we now urge the same idea upon the State of Massachusetts as a sanitary-economic question of paramount importance.

THE KARAWANKEN TUNNEL.

THE CONSTRUCTION OF A GREAT ENGINEERING WORK.

To the roll of long and important tunnels, comprising the Albula, 3.5 miles; the Turchino, 4; Arlberg, 6.4; Mont Cenis, 7.6, otherwise known as Frejus in the Italian nomenclature; the Saint-Gothard, 9.4; and the Simplon, 12.2, another was added in the latter part of last year. Although its construction was based upon what is known as the English system of tunnel building, yet it presents many features of novelty and interest, especially with regard to rapidity of execution. It forms part of a railway of the same name, which constitutes the last link of a new line of communication, established between Trieste and the northern regions of the Austrian Alps. It is situated between the stations of Rosenbach and Asling, has five miles of track, is pierced through strata of a very unreliable character, and is, therefore, lined throughout its entire length. It may be stated, therefore, that in the construction of this tunnel a new feature was grafted upon the English system, which had previously been introduced into Austria, after the experience gained and the results obtained in the perforation of the Arlberg tunnel. It is intimately connected with the planning or scheming out of those numerous practical details, which, if skillfully contrived and adequately carried out, so conspicuously conduce to the speedy and satisfactory progress of the whole work. This method consists in grouping in a special manner in the interior of the subway and arranging *en échelon*, at fixed points, a certain number of gangs of miners and masons, working simultaneously, the former at the excavation, and the latter at the stonework. Each separate gang is employed upon distinct sections or tunnel rings, which are previously assigned to it, and succeed one another in an order commensurate with the rate of advance.

The distribution of the different gangs, together with such temporary sheds and workshops as were required, was so arranged that the minimum length of open facing in progress at any particular time was not less than 3,280 feet. Both excavation and the lining and rest of the stonework were carried on simultaneously, as in Figs. 1 and 2, which represent respectively a horizontal and a vertical section along the axis of the tunnel, as will be further explained. Operations for the excavations commenced by the miners attacking the gallery *A* (Fig. 3) at the base of the section, and cutting small lateral driftings at regular distances at the points *A*, *B*, *C*, *D* (Figs. 1 and 2), which enabled them to extend their trenches into the solid earth at the top of the section, and open out the upper gallery *B* (Fig. 3). So soon as the latter gallery was sufficiently advanced it was divided into a number of equal partitions, corresponding to the tunnel rings already mentioned (Fig. 4). These rings are 27 feet in length, and are classed under three heads—*A*, *B*, and *C*. This division effected, excavating operations were at once resumed throughout the normal working length of 3,280 feet by the various mining gangs in all the rings included in category *A*, and the entire cross section of the tunnel dug clean out for a length of 28 feet (Fig. 4) from the upper to the level of the lower gallery. Figs. 5 and 6 show two stages of the work, and when it was completed the ring was said, in the diction of the excavators, to be "on timber," since the rings *A* were supported by four wooden centers.



Figs. 1 and 2—SECTIONS SHOWING METHOD OF BORING THE KARAWANKEN TUNNEL

In this state of the proceedings the earth gangs were sent forward to break ground at other rings belonging to the *A* class, and relinquish those of that category, already "on timber," to the stone masons. They followed on with their work over lengths of 26.3 feet, instead of 28 feet, as in the case of the excavation (Fig. 4) in order to make use of the external or end centers of the sections of *A* for those of *B*, which were adjacent to the former. The excavation and lining of the sections *B* were similarly accomplished, and finally those lettered *C*, situated between those of *A* and *B*. Care was taken not to complete the work in the different classes of sections until the two contiguous sections were entirely finished. This precaution was observed to avoid exposing too great a length of open surface of tunnel in strata of poor resistance. It was the keying in—if we may use the term in the present instance—of the intermediate rings *C*, which brought the whole undertaking to a satisfactory conclusion.

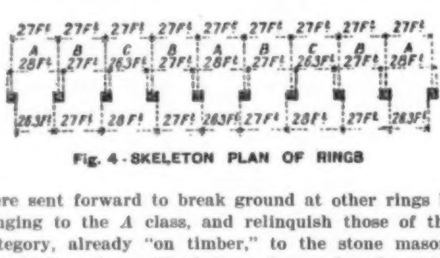


Fig. 4—SKELETON PLAN OF RINGS

In the specification for the construction of the tunnel, it was prescribed that the daily progress of the work should be at the rate of 13 lineal feet, and should comprise a complete and finished section of the entire subway for that length. The results of experiments previously carried out to ascertain the exact nature of the geological strata to be encountered warranted the assumption that the excavation of rings of class *A* (Figs. 1, 2 and 4) could be got out in forty-five working days, and the subsequent stonework and lining thoroughly effected in eighteen days more. A similar calculation assigned thirty-seven and sixteen days for the execution of the same description of work in *B* section, and twenty-nine and fifteen days respectively were estimated to be sufficient for the remaining *C* rings, flanked on each side by those of the *B* class. In accordance with this programme, and from what has been previously stated, it is evident that the excavators and masons pursued their several tasks under normal conditions, contemporaneously, in a series of distinctly separate sections or rings, as is plainly indicated in Fig. 4. Commencing with the excavations, they were in full progress in the seven rings, figured 1 to 7, in Section I. of the tunnel (Fig. 4); also at the same time in the twelve rings of class *B* in Section III, and in the five junction rings *C*, figured 1 to 5 in Section V. of the tunnel. Turning now to the stonework. While the operations just described were in progress, this was in process of building in the four rings, 1 to 4, in Section II.; in the six rings of class *B*, 1 to 6, in Section IV., and in rings *C*, 1 to 3, in tunnel Section VI. We have now accounted for the quality and quantity of the work executed in all the six sections, corresponding to the developments (Figs. 1 and 2). Gangs were then redistributed over another 120 rings, constituting the normal sub-length of 3,280 feet, and the working routine commenced *de novo*. Circumstances sometimes occurred, as might be reasonably expected, which rendered it impossible strictly to adhere to the predetermined plan of action, but balancing the excesses and the deficits of the daily advances, a very satisfactory average was arrived at. This is obvious from the fact the tunnel was commenced in June, 1902, and completed in November, 1905. According to our authority, the Oesterreichische Wochenschrift für den offentlichen Baudienst, the rapidity with which tunnels in Austria have been pierced by this method, fairly entitles it to the appellation of the Austrian modern system of tunnel building. It will be remembered that in our issue of June 2, 1905, we gave an account of the equipment used in this work.—The Engineer.

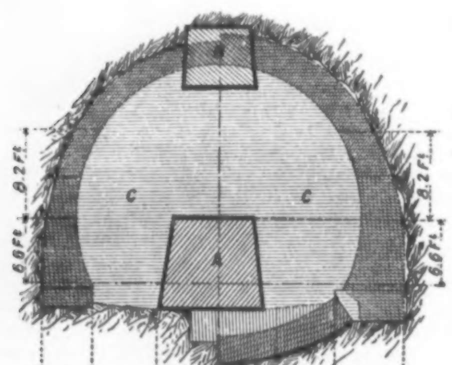


Fig. 3—CROSS SECTION OF TUNNEL

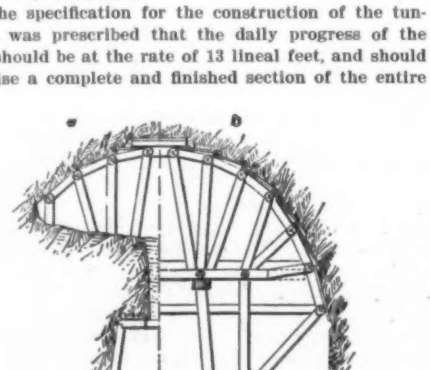


Fig. 5—CROSS SECTION OF TIMBERING

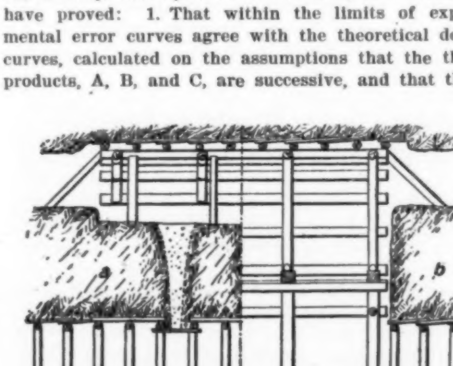


Fig. 6—LONGITUDINAL SECTION OF TIMBERING

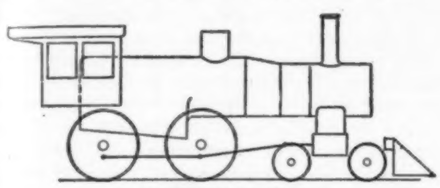
Dr. H. L. Bronson is continuing his researches on the decomposition products of radium, and claims to have proved: 1. That within the limits of experimental error curves agree with the theoretical decay curves, calculated on the assumptions that the three products, A, B, and C, are successive, and that their periods are 3, 26, and 19 minutes. 2. That radium B emits Beta-rays of less penetrating power than those from radium C; and that on this account the Beta-ray decay curves are unsatisfactory for the purposes of analysis. 3. That these Beta-rays from radium B completely explain the divergence which Rutherford found between the experimental and theoretical Beta-ray curves.

THE MODERN LOCOMOTIVE.*

THE TYPES WHICH HAVE BEEN EVOLVED.

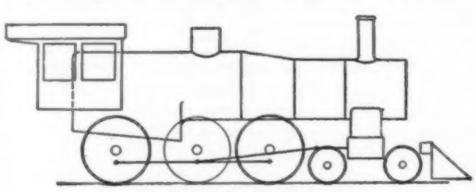
BY PAUL T. WARNER.

IT can truly be said that the steam locomotive has reached a crucial point in its development. He would be a bold prophet who would venture to say that the limit of capacity has been reached. If, however, future locomotives are to be made more powerful than the largest now building, it is probable that some radi-



AMERICAN TYPE.

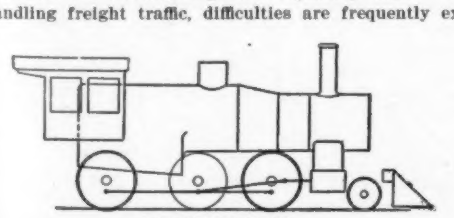
cal changes in design must be made in order that such an end may be accomplished. With the enormous amount of freight traffic handled at the present day, there is a constant demand for locomotives of increased tractive power, in order that the tonnage may be removed with a fair degree of economy. The requirements of modern passenger service necessitate the hauling of express trains which are frequently as heavy as were the freight trains of a few years ago. This fact, coupled with the higher speeds of to-day, has necessitated the construction of locomotives having exceptional steaming capacity; and the demands made upon the engines employed in this class of service are daily becoming more exacting. The electric locomotive is now entering the field, and with its increased possibility for higher capacity, is receiving great attention from all who are interested in the motive power problem. The day of the steam locomotive has not yet come to an end, but the law of the survival of the fittest must eventually decide the question; and in certain localities where special conditions exist, the electric locomotive has already demonstrated its superiority. This fact, however, is only assisting in the further development of the steam



TEN-WHEEL TYPE.

locomotive; and the problem of how its efficiency may be improved, is receiving the closest attention of motive power officials and locomotive builders.

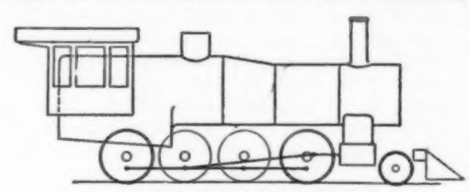
Concentration of power is essential in order to meet conditions as they exist in the mechanical world today; and the modern locomotive is a striking illustration of the fact. The locomotives exhibited at the St. Louis Exposition of 1904 showed an average increase in weight over those shown at Chicago in 1893, amounting to more than 50 per cent. So rapid has been the growth in size and tractive power, that the locomotive has set the pace for improvement in practically all other branches of railway service. Its introduction has compelled the use of stronger bridges, heavier track construction and improved shop and roundhouse facilities. The great weight of modern freight trains, made possible by the high tractive power of the locomotives employed, practically necessitates the use of freight rolling stock equipped with steel underframes, improved draft gear, and automatic couplers and air brakes. On many roads the largest locomotives are still in advance of the facilities provided for maintaining and repairing them. In handling freight traffic, difficulties are frequently ex-



MOGUL TYPE.

perienced because of the continued use of old cars having draft gear inadequate to stand the shocks and stresses to which it is subjected. The successful firing of the largest engines presents another problem, as it is almost beyond the ability of the fireman to handle the fuel required. The automatic stoker promises relief in this direction, and its more general use may be expected with the further growth of the locomotive.

As engines have increased in size, the number of types in use has been multiplied. Formerly the well-known eight-wheel, or American type of locomotive, handled practically all the passenger and a large proportion of the freight traffic of the country. It now, however, has become inadequate, and new types have been developed to meet the changed conditions. In fast passenger service, for example, the ability of the locomotive to meet requirements depends largely upon the maximum horse-power which can be developed. The boiler then becomes the limiting factor, and its capacity must be large in proportion to the tractive power of the engine. Opposed to this class of work is heavy freight service, requiring a locomotive having great tractive power and consequently ample weight on the driving wheels. As this tractive power is developed at slow speeds, the boiler power is not proportionately as great as in the fast passenger locomotive. Between these two extremes may be placed fast freight and heavy medium-speed passenger service. This work necessitates locomotives having ample weight on the driving wheels and high steaming capa-

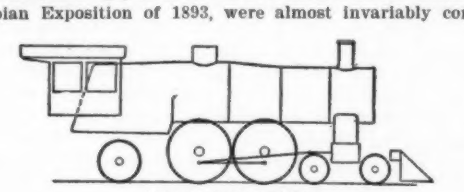


CONSOLIDATION TYPE.

city, and types of engines, which are satisfactorily meeting these conditions, have been developed. In addition, there are designs for switching and local service, heavy mountain pusher service, and other special work.

From what has been said it is evident that a consideration of the "modern locomotive" must deal with those peculiar features which have made possible the meeting of present-day demands. The source of power, in the steam locomotive, is its boiler; and therefore the first requisite in a high-powered engine is ample steaming capacity. This necessitates a grate of sufficient size to burn the required fuel at an economical rate; a fire box of ample volume and approved form, and sufficient heating surface to transmit the heat of combustion to the water, without undue waste at the stack. Provision for good circulation is also a necessity; as well as an arrangement in the front end, or smoke box, that will equalize the draft through the tubes, and result in the most efficient draft action on the fire.

Bituminous coal-burning locomotives of ten or fifteen years ago, such as were exhibited at the Columbian Exposition of 1893, were almost invariably con-

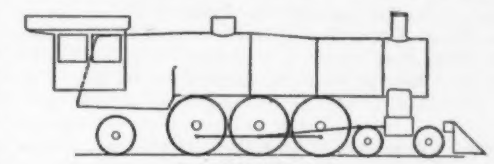


ATLANTIC TYPE.

structed with fairly deep fire boxes having the grate placed between the driving wheels. The width of the fire box was thus strictly limited. As locomotives increased in size, the grate was lengthened, until successful firing became difficult, and in the largest engines, almost impossible. The time was clearly at hand when increased grate area and boiler power were essential; and it became evident that a radical change of design, especially in the case of fast passenger locomotives, was necessary in order to secure the end desired.

In 1895 the Baldwin Locomotive Works built for the Atlantic Coast Line an engine which was the forerunner of the type now largely used in high-speed service. This locomotive had a four-wheeled leading truck and two pairs of driving wheels, which were placed as far forward as possible. The pistons were connected to the second pair. The fire box was placed behind the rear driving axle, thus permitting it to be made of ample depth and volume. To carry the resulting overhang, a pair of trailing wheels was introduced. This locomotive, to which the name Atlantic type was given, was built to fulfill a difficult guarantee, and proved successful. A large number of similar engines followed, and the type was soon adopted by other builders in this country and abroad.

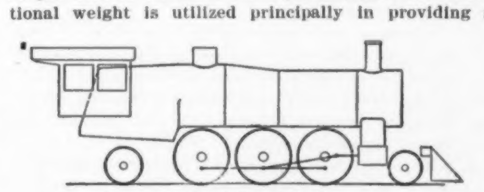
The next step in the development of the Atlantic type locomotive was to provide a wide fire box for burning bituminous coal. The grate was placed entirely behind the driving wheels, its width thus being limited only by the loading gage, while ample depth of furnace was readily secured. Thus there was developed the type of locomotive which to-day is working



PACIFIC TYPE.

a large portion of the fastest traffic, not only in this country, but also in Great Britain and on the Continent of Europe.

The addition of the trailing wheel is essential in locomotives having large driving wheels combined with deep, wide fire boxes, and a large number of types possessing these features have been developed during the past six years. The accompanying diagrams show these classes in outline, as compared with corresponding types which preceded them. The diagrams show clearly how the wheel arrangements have been modified to suit the boiler requirements. The changes noticed have resulted in providing the locomotive with increased boiler capacity in proportion to the weight carried by the driving wheels—in other words, to the tractive power. Thus the eight-wheeled engine, formerly so generally used in high-speed service, carries about 66 per cent of its total weight on the driving wheels; while in the modern Atlantic type, the proportion is about 55 per cent. Assuming, therefore, that an eight-wheel and an Atlantic type engine carry the same weight on their driving wheels, the total weight of the Atlantic type will be about 20 per cent in excess of the eight-wheeler. This additional weight is utilized principally in providing a

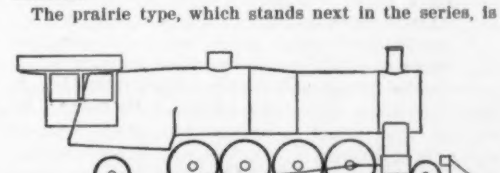


PRAIRIE TYPE.

larger boiler. Hence, while the tractive powers of the two engines at slow speeds will be the same, the maximum horse-power which can be developed in the Atlantic type will be in excess of that of the eight-wheel engine. It is for this reason that in such severe service as that between Camden and Atlantic City, for example, Atlantic type engines are able to maintain the schedules required where the eight-wheel engines have proved inadequate.

The Pacific type locomotive stands next in the series, and has been developed from the ten-wheel type. It has the same characteristics, in many respects, as the Atlantic type, and is suitable where the trains are so heavy that the tractive power required necessitates the use of three pairs of driving wheels. The Pacific type represents the most powerful class of passenger locomotive thus far produced. With the wheel arrangement and boiler design employed, the tubes are long—frequently 20 or 21 feet. Ample heating surface is thus provided, and the fire box can be made of most liberal dimensions. Where a passenger locomotive having great tractive power and high steaming capacity is desired, the Pacific type is frequently selected.

The prairie type, which stands next in the series, is



MIKADO TYPE.

a development of the well-known mogul locomotive, and is admirably adapted to fast freight service, where an exceptionally powerful boiler is wanted in combination with three pairs of driving wheels. The tubes are somewhat shorter than in a Pacific type engine having the same size wheels and driving-wheel base. The front end of the engine is supported by the fulcrum of an equalizing beam placed under the cylinder saddle,

* Journal of the Franklin Institute.

and this arrangement is liable to result in rather unsteady riding at high speeds; hence for fast service, the Pacific type is usually regarded as preferable where a six-coupled engine is required. On some roads, however, the prairie type is successfully employed in fast passenger service. Engines of this type were first used in 1900 by the Chicago, Burlington & Quincy Railway in the Middle West, whence the name was derived.

For many years the consolidation type has been (and still is) regarded as the most suitable for heavy freight service. With the moderate size driving wheels usually employed, a wide fire box can be placed over them without difficulty. If, however, an exceptional depth of furnace is needed, as is desirable for burning lignite, for example, the Mikado type is used to advantage. This class took its name from a number of locomotives which were shipped to Japan by the Baldwin Locomotive Works about ten years ago.

There are also one or two special types which have come into service during recent years, examples of which will shortly be presented. It must not be supposed, however, that the American ten-wheel and mogul types have become obsolete. They are still extensively used, and may be fitted with wide fire boxes if the wheel diameters are sufficiently moderate; but for the most severe service, where great boiler power is necessary, trailing wheels are usually required.

As has been indicated, the wide fire box was adopted in order to provide sufficient grate area, and at the same time keep the length of the furnace within reasonable limits. Ample heating surface can be secured in a boiler having a narrow fire box, but the ratio of grate area to heating surface is then so high that an excessive rate of combustion per square foot of grate must be maintained. Furthermore, in a narrow firebox boiler of large diameter, the side sheets of the fire box must curve outward at a sharp angle in order to meet the shell. It is thus difficult to secure a favorable disposition of the stay bolts, while in order to obtain the maximum width of grate possible, there is a tendency to cramp the water legs and so impede circulation. With the wide fire box, these difficulties can be avoided. The water legs are nearly vertical, and can be made of ample width without restricting the grate area.

The effort to secure improved circulation is noticeable in recent boiler designs, as is evidenced by the use of wider water spaces and more liberal tube spacing. It is found that better service is secured by spacing the tubes farther apart, even though the heating surface is thereby reduced; and the practice of filling a boiler as full of tubes as possible, in order to secure the maximum number of square feet of heating surface, is now being abandoned.

Regarding the driving mechanism, the most conspicuous development, during recent years, is found in the balanced engine. In the ordinary two-cylinder locomotive, excess weights are placed in the driving-wheel counterbalances, to neutralize the disturbing effects of the reciprocating parts. The centrifugal effects of these weights, when running, result in a periodic increase of the wheel pressure on the rail, which may become excessive at high speeds. With the advent of the heavy locomotive the problem of the counterbalance has become particularly difficult of satisfactory solution. The most logical method of avoiding the so-called hammer blow is to use four cylinders, placing the two cranks on the same side of the engine 180 deg. apart, so that the reciprocating weights oppose one another in movement, and their disturbing effects are thus neutralized. Compound cylinders can be readily applied to a locomotive of this type, and the economic advantages due to double expansion of the steam can thus be realized.

Balanced compound locomotives have been used abroad for some years, especially in France, where they are employed on practically all the high-speed trains. European designs have generally been regarded as too complicated for successful use in this country, but in 1902 the Baldwin Locomotive Works introduced a simplified form of balanced compound locomotive which is adapted to American conditions, and has given good results in service.

In the Baldwin engine, the cylinders are placed in line across the locomotive, the high pressure being between the frames, and the low pressure outside. A single piston valve controls the steam distribution to each pair of cylinders, which, with their common steam chest, are cast in one place with half the saddle. Wherever possible, the leading pair of driving wheels is moved back sufficiently to enable it to be driven by the inside (high pressure) cylinders, and is then provided with a cranked axle. The outside cylinders are coupled to either the first or second pair of driving wheels, as preferred. When the latter arrangement is adopted, the outside guides and piston rods are lengthened, in order to keep the length of the outside main rods within reasonable limits.

The crank axle has frequently been regarded as a weak point in an engine of this type, but with the materials and methods of manufacture now available this member has been so perfected that little or no trouble is experienced in service. The latest form of axle used by the Baldwin Locomotive Works is built up and composed of seven pieces, which are pressed together in a hydraulic machine. The central member is of cast steel. This form of axle, while heavier than the solid forged type, is less expensive to make, and the forged parts can be thoroughly worked and specially adapted to the service they have to perform. Should any part require renewal, it can be replaced without discarding the entire axle.

Owing to the fact that, in this type of locomotive, the piston thrusts on the same side of the engine oppose one another, the frame stresses are greatly reduced. It is found in service that these engines are practically immune from frame breakage. This is an important point, as it does away with an annoying feature which not infrequently exists in large two-cylinder locomotives.

The balanced compound locomotive, when properly handled and maintained, has proved highly efficient and economical in service. In July, 1904, the Chicago, Burlington & Quincy Railroad carried out a series of tests with engine No. 2,700, a balanced compound Atlantic type locomotive, and three single-expansion engines. The tests were run in fast passenger service, over a difficult section of the road, in which the total rise is 2,044 feet in a distance of 142.9 miles. The compound developed an average indicated horse-power hour on 24.37 pounds of water, as against 30.10 pounds for the most economical single-expansion engine tested. That is, given two locomotives, one a compound and the other a single-expansion, both having the same sized boiler, the compound can develop 20 per cent more horse-power than the other. Locomotive No. 2,700 proved its ability to make good this claim, and on one occasion made time with a train of twelve cars, weighing, with the engine and tender, 719 tons. None of the single-expansion locomotives was able to equal this performance. Subsequent tests carried out on this road have substantiated these results.

The American Locomotive Company has also produced a balanced compound locomotive, to the designs of Mr. F. J. Cole. In this engine the high-pressure cylinders, which are located between the frames, are placed in advance of the low-pressure, which are outside the frames. The high-pressure pistons are connected to the leading axle, which is cranked, while the low-pressure are connected outside, to the second pair of driving wheels. With this arrangement, connecting rods of approximately equal length and weight are secured. This system of compounding has been applied to a number of locomotives of both the Atlantic and Pacific types.

The introduction, during the past two years, of the Walschaerts valve gear on a large number of American locomotives, is a matter which deserves notice. For many years the use of the Stephenson link motion on locomotives was, in this country, practically universal. As long as engines were of moderate size, it gave satisfaction; but with the introduction of the modern heavy locomotive, certain difficulties were encountered. Axles have grown to such a size that the diameter of the eccentrics must be considerable in order to get the required throw. This increases the velocity of the rubbing surfaces, tending to result in heating. The parts of the gear become heavy and cumbersome, and their inaccessible location renders proper inspection and lubrication difficult. In order to overcome these disadvantages, a number of roads have recently introduced the Walschaerts motion. This gear, which is of the radial type, and named after its inventor, was patented in Belgium in 1844, and is extensively used on the continent of Europe. It is placed entirely outside the driving wheels, and all parts are readily accessible. The principal motion is derived from a return crank, secured to one of the crank pins. This crank actuates a link, which is trunnioned at its middle point. The movement of the link is transmitted to the valve through a radius rod, which is provided with a sliding link block; and by shifting the block from one end of the link to the other, the motion of the engine will be reversed. The return crank is set without angular advance; and, to give the valve the desired lead, a combination lever, driven from the crosshead, and connected to both the radius rod and valve stem, is employed. This lever is so proportioned that, if the radius rod be held stationary, the valve will move a distance equal to twice the lap plus the lead, during each stroke of the crosshead.

As far as the steam distribution is concerned, the Walschaerts gear differs from the Stephenson chiefly in that it gives a constant lead, while with the Stephenson gear the lead increases as the cut-off is shortened. The latter arrangement is ordinarily regarded as desirable in a locomotive, but in actual service the two gears seem to give practically the same results, and when properly designed and in good condition, neither gear shows a decided superiority over the other. The introduction of the Walschaerts gear has been due entirely to mechanical reasons, and on those lines where it is now in use, it is generally looked upon with favor.

Both the balanced slide and the piston valve are extensively used on single expansion locomotives carrying high steam pressures. The piston valve is usually made hollow, and arranged for inside admission. The pressure on the two ends of the valve is thus equalized, and as only low-pressure steam is present in the ends of the steam chest, the valve stem stuffing box can readily be kept tight. The Walschaerts gear is advantageously used with this form of valve, as it is then impossible, owing to the constant lead, for the cylinder to be sealed when the piston is at the end of its stroke. This is an important feature, as the piston valve cannot lift from its seat in order to relieve compression. It is also possible, with this form of valve, to locate the center line of the steam chest outside of the cylinder center line, and thus place all the members of the valve gear in the same vertical plane, which is desirable. The most recent consolidation and Atlantic type locomotives on the Pennsylvania Railroad may be cited as interesting examples of the use of piston valves in combination with the Walschaerts valve gear.

Brief reference should be made to the use of superheated steam. Extensive experiments along this line have been carried out in Germany, and also on the Canadian Pacific Railway, while a few other lines in this country have been trying various forms of superheaters. In the arrangement usually used on the Canadian Pacific, a certain number of boiler tubes are replaced by tubes of considerably larger diameter. These large tubes contain the superheater pipes, through which the steam circulates on its way to the cylinders. This device superheats the steam effectively; although with certain kinds of coal, the tubes are liable to become choked. The fire-tube type of superheater has been developed, in this country, by the American Locomotive Company, and has been recently modified by the Canadian Pacific Railway, which has a large number of locomotives equipped with it.

The Baldwin Locomotive Works are at present developing a smoke-box superheater. This device consists of upper and lower drums, which are connected by rows of tubes, among which the hot gases circulate while passing through the smoke box. The live steam is passed through successive groups of tubes, thus utilizing as fully as possible the heat stored in the waste gases. The first superheater of this type was applied to a large freight locomotive built for the Atchison, Topeka & Santa Fe Railroad about two years ago. It has given good results and a number of other locomotives are now being equipped with the device.

The use of superheated steam is attended with unquestioned economy, and if it is found that superheaters can be maintained without undue expense, their more general use may be expected in the future.

GLACIAL STUDIES IN THE SIERRA NEVADA.

An investigation of the maximum glaciation of the Sierra Nevada is being made by Willard D. Johnson, geologist, of the United States Geological Survey, who will this year complete a study along the full length of the east flank of the range, including a bordering zone of the Basin ranges, and will also make a reconnaissance in Carson Valley at the extreme northern end of the High Sierras. The problems involved are of great scientific interest, and considerable field work in addition to that of the present season will be required for their complete solution.

The Imperial Automobile Club of Germany is organizing an international exposition which will be held in Berlin from November 1 to 12 of this year. This date has been decided upon so as not to have the exposition coincide with the Paris or the London shows. The Emperor has promised to inaugurate it, and it will no doubt be a brilliant event. A large number of German and French automobile firms have already applied for space. The commission is composed of the Duke von Ratibor, president; Baron von Brandenstein, Carl Gause, L. M. Goldberger, Count von Sierstorpff, and others. The exposition palace is not yet entirely finished. It is situated near the Zoological Gardens, and lies very near the railroad, which is a great advantage. The space devoted to the automobile exhibits will be some 15,000 square yards under cover and 3,000 square yards on the grounds. As in the preceding years, the show will include automobiles, motor-cycles, boats, motors, airships, and accessories. The price of space is $10 per square yard in the central hall. The open-air space is reserved for the heavy apparatus, hauling cars, etc. The commission announces that it will ask the government to allow foreign exhibits to be entered for the show free of duty, and also expects that the railroad companies will give the return trip free for such objects. Further information can be obtained from Herr Rudolf Kosch, 16 Leipzigerplatz, Berlin, W. C.

Correspondence.

THE PERIYAR IRRIGATION PROJECT.

To the Editor of Scientific American Supplement:

Many of your "constant readers" will doubtless remember your previous accounts of the novel irrigation scheme worked out by the English engineers in the Madura District, South India. For the information of others, a brief review of the facts will be needed. The Western Ghauts, or Travancore Range, intercepts the moisture-laden southwest monsoon, so that the rainfall on the plains lying to the eastward of these mountains has always been precarious, often scanty, and famine has always been more or less imminent. Meanwhile, the western slope has had a superabundance of water. In 1887 plans that had long been under consideration were put in hand for building a dam across a large and useless river near the western summit of the range. Its name is the Periyar (Great River). This was to form a lake of some 8,000 acres area and setting back eight miles among the hills and up the valleys of its various tributaries. At the head of the valley nearest the summit a tunnel was cut, 12 by 8 feet in cross-section and 6,000 feet long, under the watershed, and emptying into a ravine on the eastern slope, thence running down into the bed of a large, intermittent stream, the Vaigai River. Some 60 miles from the tunnel advantage was taken of an old masonry anicut, or low dam, that had been built generations ago to shunt the Vaigai's flood-water into an irrigation channel. Here the head sluice was set up to pass some 2,000 cusecs into the main channel which, with its twelve branches and minor laterals, extends 68 miles. Much ingenuity has been shown in locating the channels along ridges, in caring for the cross-drainage, which, at the foot of steep, bare hills, is at times sudden and enormous, sometimes disposed of by over-passes, sometimes by under. The regulators, sluices, drops, viaducts, and bridges are many and costly, as all are most substantially built of stone in surki mortar.

But the main interest, from an engineering point of view, centers in the head-works—the dam and the tunnel. Here the difficulties were enormous, and many of them quite without guiding precedent. Added to the depth and swiftness of the river was its liability to sudden freshets from the heavy tropical downpour over its 300 square miles of mountainous catchment area. Some years the recorded rainfall has been over 200 inches, and as this comes sometimes in showers of 6 inches at a time, the normal flow of 2,000 has risen to the maximum recorded flow of 120,000 cusecs, or more than one-half of Niagara's 220,000. Twenty years ago the region of the dam was a dense, uninhabited jungle, and at the dry seasons so exceedingly feverish that all work had to be suspended for this cause alone. Labor had to be imported, its superstitious fears allayed, its ignorance and sloth had to be patiently dealt with, and its utter disregard for sanitation overruled. Wild elephants roamed the jungles and committed much mischief and caused more fear. All the machinery, plant, and stores had to be hauled 76 miles from the railway by oxen and elephants, across unbridged, sandy stream beds and up a steep, crooked mountain path. Labor was scarce and had to be paid unusual rates. Delays were frequent, and in the many emergencies that arose resort had to be made to all kinds of expedients. Owing to the pressure of work in other parts of this great land and, possibly, to a gradual appreciation of the magnitude of the task, at no time were there more than five Englishmen, trained engineers, on the spot, and this number was often reduced by fever and accident. Over and over sudden freshets came down, when no rain had fallen in the vicinity, and carried away portions of the work. Plans had to be changed on account of changing conditions. But, in spite of interruptions and losses, the dam was formally closed October 11, 1895, and water was let into the channels June 20, 1897. Nearly 50,000 acres were brought under irrigation the first year and this has now amounted to about 150,000 acres and pays a net income of a little over 4 per cent on the total investment of about three and one-third millions of dollars, divided, roughly, about evenly between head works and distribution.

The main dam is 1,241 feet long, 176 feet high above the bed of the river, 144 feet 6 inches wide at the base, and 12 feet thick at the crest. The front and rear walls are of rubble masonry and the core of surki mortar concrete. The spillway is over a saddle in the right bank, 434 feet long and blasted down to 22 feet below the crest of the dam. On the left bank there is an extension of the main dam, 221 feet in length, to close a smaller saddle.

All great dams leak some. It is very interesting to learn that, in spite of the enormous pressure upon the face of the dam, its leakage has been found, after careful measurements, to have steadily dropped from one-fourth to one-twelfth of a cubic foot a second, which, for an area of about 72,000 square feet, may be considered negligible. The percentage of lime in the water has decreased considerably after the first two or three years.

Two very great improvements are now under consideration, the one, to increase the storage capacity, at the same time making available more of what is now stored; the other, to make the outflow through the tunnel constant, so as to be able to utilize its power for the generation of electricity.

To take up the latter first: during the summer months of March to May the country is so dry and hot that it is found to be uneconomical to send water over long distances for irrigation purposes, and if the flow were made constant during these months for electrical generation there would have to be a dam nearly a mile long thrown across one of the valleys of the eastern slope. A specially dry season occurred which showed that the water now available would not be sufficient to furnish the necessary power, so, in addition to the work to be described below, an adjoining valley is now being investigated with the view of diverting its waters into the Periyar Lake. But as tenders for any considerable part of the 50,000 horsepower that it is calculated could be generated have not yet been received, the government delays undertaking the great expense involved.

The other improvement is already in hand and is nearing completion. The tunnel is connected with the lake by a 21-foot cutting over 6,000 feet long. The sill of the sluice is 106.68 feet above datum, but the crest of the cutting is 115 feet above datum. This cutting is being widened to 35 feet and is being lowered to sill-level, thus giving an additional 9 feet of gain in available supply. At the spillway heavy granite piers have been built and ten sluice gates, each 36 feet long by 16 feet high, are being set up. This will give a further gain in storage capacity. It is estimated that both of these improvements will give a gain of 70 per cent of the present 6,000 millions of cubic feet of water now available, or a total of 10,200 millions of cubic feet, at an added expense of only about $200,000.

This last improvement is made possible only by the Stoney patent shutter, which is already in use at the tunnel head and at the main sluice. It has been in use in other parts of India for the last twelve years, but not very generally, and only once or twice in England. Its principle is a series of vertical steel plates riveted to a series of horizontal bow-string girders. It is suspended with heavy counterpoise weights and is raised and lowered by means of a winch, overhead, which acts upon a geared shafting carrying at each end a sprocket wheel actuating a bicycle-pattern chain. The back of the ends of each shutter rests upon two sets of cast-iron rollers set vertically in recesses in the masonry. These rollers, in turn, rest on a rocking plate, which has a machined steel face, and three strong webs at the back, the middle one longer than the other two, and rounded at the corners, thus permitting it to rock freely, like a knife-edge, on a machined steel plate bolted to the masonry. Thus, however much the shutter may bend under the pressure of the water on its face, it and this knife-edge or rocker plate will always present parallel faces to the set of rollers between them. To prevent excessive leakage, the work is most carefully carried out to the eighth of an inch, the sill guides and angle irons lining the masonry being machined. A further device is the staunching bar, a steel rod of about 1½ inches diameter, which is let down between the upstream face of the shutter and an angle iron which lines the recess corner of the pier. The bow-string girders at the back of each shutter are five in number and spaced more closely at the bottom to resist the greater pressure. The two top ones, in addition to other bracings, are joined at each end by a 3-inch eye-bar into which the two sprocket chains fasten, thus distributing the strain of raising the 15-ton shutters. The steel work, all ready to be assembled, is sent out from England by the great engineering firm of Ransome & Rapier, of Liverpool. The construction is being carried out by the executive engineer of the Public Works Department, Mr. A. R. de Chazal, to whose kindness I am indebted for much of the information obtained.

E. P. Holton.

CENSUS OF METAL-WORKING MACHINERY.

The census of metal-working machinery, 1905, prepared by Mr. Fred. J. Miller, expert special agent, gives a comprehensive view of the extent and the distribution of the manufacture of metal-working machinery in the United States. The term "metal-working machinery" does not include machines or tools for use in the hand trades, such as plumbers' and tinsmiths' tools, and watchmakers' lathes and tools, or rolling mill machinery, cranes, hoists, etc., but merely what is ordinarily termed machine tools and small tools. The last census of this kind was taken in 1900, and the report gives a comparison of the figures in that year with those in 1905, and also states the percentage of increase of the value as well as of the number of machines being built. The greatest production of metal-working machinery at the census of 1905, which, in fact, records the figures for the year 1904, was reported for Ohio, which State also stood first in 1900. The value of metal-working machinery manufactured in Ohio forms not less than 25 per cent of the total value of all metal-working machinery manufactured in the United States, and is greater than the combined product of New York, New Jersey, and Pennsylvania. As is well known, this industry in Ohio is concentrated in Cincinnati and Cleveland, which two cities together produced three-fourths of the total value of all metal-working machinery in the State, or nearly one-fifth of all the metal-working machinery manufactured in the United States. Cincinnati is the leading city in the country in this industry, producing, as it does, almost exactly one-tenth of all the metal-working machinery of the country. Massachusetts is the second State in the Union in regard to the value of its machinery products, Worcester being the leading city in that State. Connecticut takes the third place, the leading manufacturing city for this class of machinery being Hartford. New York State takes the fourth place, and New York city is the third city in the United States in regard to the value of production, the bulk of its manufacture being located in Brooklyn. Pennsylvania, which was the second State in the manufacture of metal-working machinery in 1900, sunk to the fifth rank in 1905, but Philadelphia retained its fourth place among the cities of the United States. The fifth city in this respect is Providence, producing 86.2 per cent of all the machinery of Rhode Island, which is the seventh among the States of the country in this industry, the sixth place being held by Illinois.

In regard to the class of machinery manufactured, the census shows that while lathes are the principal class of metal-working machinery, the value of this product as well as the number of machines decreased most remarkably during the five years since the last census. Ohio ranked first in the production of lathes, reporting about one-third of the total number, and more than two-fifths of the total value. The production of milling machines showed a slight decrease in regard to the number of machines manufactured, but there was an increase in the value of such machines of 14 per cent. Rhode Island and Ohio ranked first as the leading States in the manufacture of these machines. A remarkable increase is shown under the heading "All other metal-working machinery not specified," which includes small tools, chucks, precision tools, and special machines for duplicate parts. The total value for small tools for metal-working machinery manufactured in the United States in 1904 was more than one-seventh of the total for all classes of metal-working machines. In the census, only tools for use in power-driven machinery are reported as small tools, but it is possible that some hand tools have been included. However, as there may be some manufacture of this class of apparatus not reported, it is probable that the figure given is a fairly accurate report of this branch of manufacture. The value of special machinery for the manufacture of duplicate parts, and special machinery not specified, amounted to more than one-tenth of the total of all metal-working machinery. Massachusetts was the principal State in the manufacture of small tools, and also in precision tools and machines, with Connecticut second in rank in the former, and Rhode Island in the latter manufacture.

If the foreign trade in iron and steel manufacture and machinery may be taken as an index of the condition prevailing in the various branches of that industry, the figures of the census clearly show that the manufacture of metal-working machinery was somewhat depressed during the five-year period recorded by the census. The exports of iron and steel manufacture and machinery decreased steadily, year by year, from 1900 to 1903 inclusive, and although in 1904, when the business conditions in this country were improving in the iron and steel industry, the increase in exports was materially greater than the years preceding, the exports in that year still were considerably less than those of 1900.

While the total production of metal-working machinery in the census of 1905 shows an increase as compared with the census of 1900, it must be remembered that the statistics of the latter year were not as complete as those of the former.—Bulletin 67, Department of Commerce and Labor.

Fonte Argentine, which is, according to the Metallarbeiter, tinned cast-iron, is prepared as follows: Dissolve in 250 parts of water 3 parts of pyrophosphate of soda and ½ part of ordinary and ¾ part of dried and melted tin salts. Heat the whole to 80 deg. C. and immerse the iron objects with some tin rods. On a large scale, the fluid and the objects to be tinned are placed in a large cask that turns on an axis, and which, with the aid of suitable mechanical devices, can be set in motion.

ENGINEERING NOTES.

Particulars of the coal consumption of the turbine steamer "Virginian," running between Liverpool and Montreal, have recently been published. In a series of voyages the boat has averaged 17.2 to 17.65 knots at an estimated power of 12,700 I.H.P. The average coal consumption for the propelling machinery only was 1.30 pounds per I.H.P. Including the auxiliary machinery it was 1.42 pounds; and including electric light also, 1.507 pounds.

For destroying weeds on the track a car has been experimentally fitted by the Illinois Central Railroad. The car carries two tanks, each of 4,000 gallons capacity, from which a perforated pipe under the car is fed. Through this the ground is sprayed with a chemical solution. While one tank is being emptied, chemicals are being mixed in the other, the water which forms the bulk of the solution being obtained from stations along the line.

A committee delegated to examine the report of the State railways has recommended the completion of the second Simplon Tunnel to the Swiss Legislature. The Simplon was projected to have two single-track tubes, the second being temporarily put through as a heading only, useful for drainage and ventilation and permitting full excavation when needed. According to the original contract, this work if commissioned before February 23, 1908, may be made a part of the first contract, and the committee recommends that this shall be done.

The first large American turbine ship, the "Creole," left New York on her maiden trip on July 14. She is the property of the Southern Pacific Company, and will run between New York and New Orleans. The "Creole" is one of three vessels of her size and type just built for the Southern Pacific Company by the Fore River Shipbuilding Company; she is the only one fitted with turbines. She is 440 feet long, 57 feet beam, and 10,600 tons displacement, and has a speed of 18½ knots an hour with a cargo of 4,500 tons. She has 152 staterooms and accommodation for 250 steerage passengers.

Street railway car houses are to be reported on at the coming meeting of the American Street and Interurban Railway Engineering Association in October, 1907. The report will be prepared by a committee on operating and storage car house designs. The report will "consist of a compilation of plans and synopsis of specifications of some of the more recent types" of car houses. Besides specifications, the committee requests descriptions of such houses, and also drawings or photographs showing front elevation, drawings showing plan of tracks, pitroom, etc., cross-section of walls, roof and pits, and detail drawings of special features.—Engineering News.

The enormous covered reservoir which is under construction at Honor Oak, Camberwell, for the Metropolitan Water Board of London, contains a number of unusual features in the design of the walls. The reservoir will contain about 70,000,000 gallons, and is divided by two intersecting interior walls into four basins, with a gatehouse for all the basins at the intersection. Here the connections are so arranged that each basin can be operated independently of the others. A part of the reservoir is an excavation, and here the walls are arched in plan, while the outside walls elsewhere are of ordinary section for retaining walls. The central walls are also arched in plan, 6 feet thick at the center of each bay and 10 feet at the heavy brick buttresses which separate the bays. These buttresses are likewise used along the outer walls, and are carried up to form part of the roof supports. The floor is made of inverted arches, supporting at the high points brickwork piers 14 feet high, which carry the jack arches for the drum vaulting of the roof. The brick used in the work were made from the clay excavated from the site.—Engineering Record.

The entrance to the port of Liverpool, as in the case of New York harbor, requires constant dredging in order to provide easy access to the docks for vessels of large draft, such as those of the White Star Company and the forthcoming Cunard liners. Hitherto this work has been carried out upon limited lines; but owing to the rapid progress that is being maintained in connection with the increase in size and draft of succeeding transatlantic vessels, it is realized by the harbor authorities that in order to keep pace with such constructional development, dredging must be undertaken upon a more extensive basis. It is now proposed to widen and deepen the navigation channel from the sea, so as to take ships 1,000 feet in length by 40 feet draft with ease, and for this purpose it has been decided to construct a dredger, the pumping capacity of which will be equal to the three largest dredgers at present in use on the Mersey, and which when completed will be the largest and most powerful vessel of this class yet constructed. The dredger will be of 10,000 tons and will be designed on the centrifugal sand pumping system.

ELECTRICAL NOTES.

Prof. Barde, in a paper read before the Agricultural Section of the Society of Arts of Geneva, gives an account of certain experiments demonstrating the efficacy of utilizing atmospheric electricity in destroying the phylloxera of the vine, and also in promoting to a remarkable degree the vigorous growth of plants generally. The discovery was first made by a cultivator of vines. The method consisted in the arrangement of two series of metallic conductors traversing the roots at a depth of about sixty centimeters, so as not to injure the above-ground portion of the vines. Each series of conductors forms with the plants it traverses an electrode, and electric currents are liberated by neighboring electrodes of contrary signs. One of the collectors is bound to a lightning rod, about twenty meters in height, furnished at its extremity with a quantity of small copper points. The other is attached to a metal plate, buried in the ground. The experiment was tried on vines badly infested with phylloxera, and at the end of the first season it was found that most of the insects were killed, and at the end of the second season not a single living insect could be discovered. In addition to destroying the phylloxera, it was observed that the treated vines grew much more vigorously than a check batch of untreated ones; the quantity and quality of the fruit were also much better in the treated batch. This primitive method of applying electricity has been modified by Prof. Barde, who finds that in place of a current of about 120 volts, as first used, currents varying between 1,000 and 2,000, or even 3,000 volts can be applied without producing the slightest injury to the plants treated. The paper closes with the announcement that this discovery has been patented in various countries, and that all rights are vested in the Société suisse d'Electroculture.

An interesting address on electric conduction was delivered by Dr. C. P. Steinmetz before the American Electrochemical Society. Dr. Steinmetz says there are phenomena outside and inside of a conductor. Outside there are electromagnetic and electrostatic stresses, and inside of the conductor conversion of electric energy into heat. It is usual to distinguish different classes of conduction. The briefest definition of metallic conduction is perhaps that metallic conductors are those in which energy is converted directly into no other form but heat. They have in general a positive temperature-resistance coefficient, but this rule does not hold for alloys. Electrolytic conduction is always accompanied by chemical action. The resistance of electrolytic conductors is, in a general way, about one million times higher than that of metallic conductors. As a rule, electrolytic conductors have a negative temperature-resistance coefficient. Thirdly, in the case of gases and vapors, much work has been done in recent years to extend the ionic theory (which originated from electrolytic conductors) to the conduction of gases and vapors. Dr. Steinmetz thinks these are mere theoretical speculations or rather pictures of what happens, but not facts. Such hypotheses are often useful, but may later on be discarded, or, as is now the practice, they are amended and reamended for the sake of continuity so that a hypothesis may become later on something quite different from what it was before. Since there are enough disturbing factors in the actual experimental measurements, Dr. Steinmetz proposes not to introduce another source of error—namely, theory. He proposed to deal simply with experimental facts. In gases and vapors there are two different classes of conduction. First, the electric discharge (Geissler discharge at reduced pressure and the spark at ordinary pressure) is characterized by the fact that the discharge passes through the gas and vapor which already fills the space. Second, the arc is characterized by the fact that the current is conducted through a vapor which is produced by the arc itself from the material of the electrodes. The arc is continuous, the discharge is discontinuous. By spectroscopic measurements or by simply looking at the arc it is possible to determine what the material is which carries the current. A positive magnetite electrode with a negative carbon electrode give the carbon arc. A negative magnetite electrode with a positive carbon electrode give the iron arc. A negative magnetite electrode and a positive copper electrode give also the iron arc. These are illustrations of the general rule that the material which produces the vapor and transports the current in an arc is that of the negative electrode. In general, an alternating current cannot maintain an arc (carbon being an exception) just for the reason that the arc requires a vapor stream from the negative electrode, and with alternating current the electrodes change their polarity every half period. Alternating current arcs are possible only with materials whose boiling-points are so high that the disruptive voltage is higher than the voltage required to maintain the arc. As a general rule one can shift from positive to positive electrode, but not from negative to negative. Thus continuity at the negative is absolutely essential.

TRADE NOTES AND FORMULÆ.

Cement for Steam Pipes.—*a.* Leadless oil cement: Graphite 12 parts, heavy spar 16 parts, slaked lime 6 parts, boiled linseed oil 6 parts. *b.* Steam-pipe oil-cement. No. 1: Litharge 25 parts, lime (burned and air slaked) 10 parts, quartz sand 10 parts, are mixed with hot linseed oil and thoroughly worked together in a hot mortar. No. 2: Graphite 60 parts, lime powder 50 parts, washed heavy spar 60 parts, linseed oil 35 parts.

Covering Mass for Steam Pipes, etc.—100 parts of finely pulverized limestone, 350 parts of finely ground coal, 250 parts of clay meal, and 300 parts of floating ashes from the boiler flues are mixed thoroughly with 600 parts of water and 10 parts of sulphuric acid (50 deg. B.), and after adding 15 parts of hair, the whole made as nearly as possible homogeneous. Apply in layers of about ½ inch to 1½ or 2 inches; paint with any desired color.

To Paraffine Wood.—The wood, according to a communication in the Bayr. Industrie und Gewerbeblatt, is placed in paraffine and kept immersed in the latter, at a temperature considerably above that of boiling water—to about 140 deg. C.—until gas bubbles cease to rise. Then allow it to cool off so gradually that the air pressure has opportunity to fill the pores with paraffine. Wood thus treated will insulate statical electricity. Paper can be drawn slowly through the heated paraffine—over 100 deg. C.—so that at the same time the water will be driven off, and during the cooling the surplus will drop off.

Practical Experience in the Treatment of Flour.—According to the advice of Deutsche Mühlen Industrie, wheat and rye flour should never be allowed to lie packed tightly into sacks nor for a long time in the same place. Loose flour should be shoveled over at least once every two months. Flour packed in sacks must be turned over every month. In moving, the sacks must be turned, so that they occupy a different position. If this precautionary measure is neglected, the flour, after five or six months, will become lumpy, acquire a musty odor, fall off in baking quality, and the baked goods made from it will have a pale color and an unpleasant odor.

Turning Black of Fruit Wines.—Following are the precautions to be adopted to prevent fruit wines from turning black, according to P. Carstensen, Instructor in Viticulture in Bacharach (in Geisenheimer Mitteilungen). In selecting the fruit, care must be taken to preserve a right proportion between kinds poor in acid and those rich in acid—soft pears must be mixed with apples that are rich in acid. Care must also be taken that all iron vessels used in the preparation of the must are not only thoroughly cleansed, but have received a timely coating (in summer is best) of enamel varnish. To fruit wine, which is thin in itself, we should not add large quantities of water if we anticipate a durable wine. A greatly thinned cider not only shows an inclination to turn black, but is susceptible of every disease to which a wine is subject. Finally, the first drawing of a fruit wine should be made at an early date.

Making Illuminating Gas from Dense Coke and Coal Dust.—Fine coal and coal dust, as poor as possible in ashes (says Der Gastechniker) is first to be mixed in a dry condition with a suitable binding substance, pitch, for instance, and then under great pressure, formed into briquettes of dense texture. The coal particles are pressed so closely together by this means that the coking proceeds inside the briquette, and from the gas retort coke in pieces the size of the briquettes is obtained. Owing to the employment only of dry coal for the briquettes, the development of water vapor in the distillation process is avoided, so that neither the quality of the gas nor the density of the coke briquettes suffers. In order, at the same time, to remove the sulphureted hydrogen from the illuminating gas, which prevents the rational saving of the valuable cyanogen in the ordinary purifying process, finely crushed lime is added to the coal dust impregnated with binding material, before it is pressed into briquettes.

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